CHEMICAL
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A consolidation of

ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* **IRON & STEEL MAGAZINE**

Facts First;
Classification Second

THE coal operators shipping over the Virginian Railway for export through the Sewalls Point Coal Exchange are taking a very advanced stand in their agreement with the United States Bureau of Mines with regard to the sampling and analysis of coals. They propose to have a complete set of mine samples and analyses, tipple samples and analyses, and commercial coal tests throughout the year to serve as a basis for determining the classification of their coal shipments.

As in all such co-operative agreements, all analyses obtained by the bureau may be published, and all users of smokeless and high volatile fuel from this district can therefore profit by the conclusions. This work will be of great value to other users of coal from this territory as well as to the tidewater and foreign interests directly concerned in the shipments handled by this coal exchange.

This is practically the first time that a large group of operators have been willing to face the facts so frankly; they and their patrons are to be congratulated accordingly. It is not too much to expect that other districts will fall in line, so that all users of fuel may ultimately have reliable mine- and commercial-coal analyses as a basis upon which to judge their purchases. The time is coming when a coal purchaser may again buy upon quality. Just now, of course, he has to take what he can get and be thankful for that. When quality again becomes the determining factor such work as this just undertaken will have increased value for all.

New Problems
In the Chemical Industry

HIGH prices and increased transportation costs necessitate industrial adjustment. In what way will this adjustment affect the chemical industry?

Like others, the chemical industries have shown a marked tendency toward centralization and large-scale operation. This has not been illogical and has done much to bring about the high efficiency and the present position of importance of the chemical industry in this country. There were other and less apparent causes for centralization, among which the low cost and ease of transportation and a relatively concentrated market were important. Also there was a lack of appreciation on the part of the investing public of the economic importance and industrial stability of the chemical industry. Men whose initiative, ability and training fitted them to establish and operate small chemical plants felt that the large chemical companies offered more attractive employment and a greater opportunity.

Now, however, the conditions have changed in a marked degree. Industrial expansion throughout the country and more particularly the increase in general manufacturing in Western states, which has called for larger quantities and varieties of chemicals, have emphasized the burdensome effect of centralization in those sections distant from the source of the needed chemicals. Transportation difficulties and more recently the increase in freight rates have forcibly emphasized this effect of centralization. As a consequence interest has been stimulated in small-scale production to supply a local market.

Undoubtedly the small plant will become an increasingly important factor in the chemical industry, and bring about a new set of problems for chemists and chemical engineers to solve.

Why Not a
Revolving Fund?

CHEMICAL Warfare Service is to embark upon many activities which have possible peace-time value. These activities should be fostered, for the Service can be most effective in war times if it has been allowed to be business-like and effective in times of peace. One specific proposal is that a portion of the war-gas reserves be sold each year and a new supply be made in the plants of C.W.S. to replace the amounts disposed of. This would permit only fresh stocks to be kept and continual attention could be given to revision of manufacturing methods and maintenance of plant and equipment in genuine working order.

Any such program still has one important limitation, however. The income from such sale of materials would not be credited to the accounts of the Service for further developments and operations. It is a general practice that such income incident to any Government activity "be covered into the Treasury as miscellaneous receipts." In other words, the Service, although in effect financially self-sustaining, has each year no income credited to it, for these miscellaneous receipts do not appear as part of its assets. Occasionally a somewhat different practice is followed under what is termed "a revolving fund." An appropriation for this purpose provides that any income from the work authorized shall be credited to the appropriation and thus be allowed to facilitate an extension of the work or its continuance beyond the time that the initial appropriation would provide for.

Far be it from us to encourage Chemical Warfare Service or any other branch of the Government in the thought of "going into business" in competition with established industry. However, to remain an effective military agency this department must be maintained upon a business-like basis. A most effective means to

this end would be the transaction every year of a small amount of business directly associated with industry. The personnel of the Service would thus be kept in touch with industrial conditions most effectively and would know just how the current work could most quickly be expanded to a larger scale in case of military emergency.

A relatively small appropriation will permit fairly large-scale operation of the Service if the appropriation is on the basis of a revolving fund. On the other hand, if definite appropriations for all work must be made every year and income simply goes into the Treasury of the United States, we know there must be a continual fight in Congress to obtain the necessary money. Each year the effectiveness of the Service will be jeopardized by the possibility of political attack or unreasonable so-called "economy." It seems that an appropriation on the basis of a revolving fund would have great merit in these circumstances.

Fees vs. Salaries
For University Professors

NOTING the inadequate technical instruction in iron and steel now existing in America, not only in trade schools but more especially in the so-called institutions of higher learning, the president of one of our honorably known colleges set out to find a professor of ferrous metallurgy. He wanted to find a man of personality such that men in the surrounding industry would naturally come to him for advice; the new professor was to be an executive who could lay the foundations for a great department; he must know iron and steel metallurgy and metallography, and be able to speak and write on these subjects clearly, easily and convincingly.

Some well-meaning friend referred Dr. PREX to us for a list of possible candidates. After hearing the specifications and learning that the salary of $4,500 a year was offered, the answer was instant: "It simply can't be done! Metallurgists of that caliber are extremely rare. If you could find one it would be difficult to interest him at twice the figure. If you succeed it will be pure good fortune."

"True," said the visitor, "but I hope to interest some man already a teacher, or with a desire to become a teacher, who is perhaps even now occupying a subordinate educational position, and who might not be held by a consulting practice, and therefore be willing to make the change for the opportunity it offers."

Here, indeed, is a phase of the situation only now being realized by educational administrators. Granted that an engineering professor should do some consulting work in order to keep him familiar with the shifting advance of technology, it is often forgotten that the teacher's first duty and great opportunity is to instruct and inspire his students. If his salary for this welcome task is so pitifully inadequate that financial worries and half-baked consultation fill his mind and time, then the teacher is teacher in name only, he loses his upright independence and the honorable title "Professor" is truckled to quack and charlatan.

Inbreeding and stagnation in university faculties are an ever-present danger from many causes without tying a teacher to a certain city or region simply because he is reasonably sure of certain outside fees. Why should he go from hardly won pound cake at Harvale to several years of bread and butter at Illiota?

Dr. PREX has evidently seen the great need of competent instruction in iron and steel. When will his board of directors apply to college management the same principles which rule their business: that the man and not the salary is the thing of importance? They know that if they get the right man he will earn the salary he will ask, but it seems they have not yet received sufficient urge from teachers, alumni or industry to act upon that knowledge.

An Excellent Publication
On Hydro-electric Power

A PAMPHLET has been circulated by the Guaranty Trust Company which looks like good tidings. It urges investment in hydro-electric enterprises. It consists in a study of the power facilities of the United States, recognizes the prospective exhaustion of our oil supply with the increasing demand made upon it and the imports, running up in 1919 to 70,000,000 barrels. The burden upon railways for carrying coal is considered, as is the increase of 175 per cent in the cost of coal at the mines since 1914. The immense saving of labor and in traffic to be obtained by the development of water-power stations instead of hauling coal and the reasonableness of co-ordinating these with central-power stations fed by steam and gas are set forth with such clarity that it seems—of course this is a venturesome statement but it *almost* seems—as if it might make the dear public understand something of the thefts that we of today are committing against unborn generations.

There is told also how in the electrified mountain section of the Chicago, Milwaukee & St. Paul Railway (which formerly bore the initials C., M. & P. S. and was sometimes referred to as the Chicago, Milwaukee and Paint Saul), the company found that one electric locomotive does the work of four steam locomotives. The Butte, Anaconda & Pacific Railway accomplishes with seventeen electric locomotives work that formerly required twenty-eight steam engines of the mastodon type. The Norfolk & Western Railway achieves similar results. The interconnection of seventy-five hydro-electric with forty-seven steam plants in California covers a distance of over 800 miles with 7,200 miles of high-tension transmission lines, having a capacity of 785,000 kilowatts and serving nearly 600,000 consumers. California uses more electric power on farms (chiefly for pumping water for irrigation) than all the rest of the farms in the United States. The California rice industry that began in 1912 and that last year produced a crop worth $27,000,000 is almost wholly dependent on electric pumping.

In Kansas this summer the wheat of at least a dozen counties was threshed by electricity. One company supplies power to sixty towns and 500 farms. In Montana and Idaho the mines and smelters are electrified, and in the Northwest paper mills and sawmills are using electricity for power. And the immense significance of long-distance transmission whereby manufacturing concerns may select the most convenient locations, instead of building out at the falls, is emphasized.

We congratulate the Guaranty Trust Company on rendering a real service in public education. The public is naturally conservative in regard to what it does not understand, and this is as it should be. But it is also very slow in trying to understand, and this is as

it should not be. There are indications, however, that the passage of the water-power bill at the last session of Congress is stimulating hydro-electric development in this country. Up to September 19 the Federal Power Commission had received fifty-six applications for preliminary permits and licenses. These applications are being filed from all parts of the country and the power is to be used for a variety of purposes, including mining, irrigation and public utility service.

Don't Forget
The Time Element

A GREAT many persons by losing sight of the time element, are in danger of misinterpreting or of failing entirely to percieve the economic changes that are in progress. They forget that time has passed and time is passing. That is a common fault. It is the chief thing, for instance, that makes an "old fogy" what he is. The passage of time makes less impression upon the older man and he expects events to move less rapidly in keeping with his duller impression. The man who does not become an old fogy is the one who makes allowance for the change in personal equation.

We are in a period of particularly great changes and especially rapid flux by reason of the great war having occurred. The passage of time is especially important as suggestive of the passage from one set of conditions to another set and still another. What many men neglect to allow for is the fact that almost two years have passed since the Armistice.

The idea entertained during the war in some quarters that there would be a period of readjustment or a "transitionary period" from war-time conditions to stable peace conditions in the matter of business and the affairs of men generally has been shown to have been altogether erroneous. We are to have continued changes. At the present time there is in progress a downward readjustment in the values of many things. In the case of commodities, the great bulk of commodities is included. In the case of labor, the rates in money per hour or per day do not decline, but the performance increases, and while the labor unions consider labor a commodity to be weighed out simply by time, the fact is that in the long run the workman sells performance, which one may regard as service rather than as a commodity.

There are not a few who shrink from the mere contemplation of such a thing as declines in the prices of commodities. They seem to think it will spoil everything for prices to decline. They forget that almost two years have elapsed since the Armistice. They fail to allow for the progress of time. We have had a period of price advances—and quite a long period considering how rapidly things would naturally move after such great disturbances as the World War could not but produce. It is only natural that at some time prices should decline. During the war the common prediction was that there would be a "period of prosperity" after the war, and some predicted only three years of that. Well, two years have elapsed and they have not been years of real prosperity, which means both progress or advancement and contentment. These things obviously we have not had, and if they were possible in the circumstances that existed they would have obtained. Others, the most sanguine, predicted a period of seven or eight years of "prosperity." Assuming for argument that they were right, a fourth of the period has passed and has been practically squandered. If the fates really do decree that when mankind indulges in a great war with enormous destruction of life and property and great waste of time it shall be rewarded by being given a period of riotous living, how many years of such reward is mankind entitled to receive?

The thing to do is to recognize that the two years have not given us real prosperity and that they represent an amply long period for the experiment. We should be glad to see things change, for any change would be promising of better luck in the next experiment. If we do not have changes, if we do not try various means of arriving at real prosperity, we might as well take it that the world has gone to the dogs to stay there.

First in War, First in Peace, and
First (?) in the Hearts of the Congressmen

T HE Chemical Warfare Service is undertaking a most desirable public responsibility when it seeks to apply during peace time some of the important results of its military preparedness. The chemist can do well to follow the various activities of this Service, for doubtless much of its effort will prove to have immediate commercial application as well as the military value primarily sought. In this connection it is interesting to note the efforts toward rat extermination with poison gas, the possibility of poison-gas bombs being used in the capture of criminals who have barricaded themselves in inaccessible places and the destruction of grasshoppers and other pests by appropriate offensive gas preparations. These, of course, have a popular as well as a technical interest.

To the chemical industry it will be more interesting to consider the proposal that the stocks of war-gas materials be used industrially to a certain extent each year. By this plan it is hoped that the facilities and equipment of the Service may each year be actively in use on a small scale and thus be more easily maintained up to date and in operating condition. The sale of 25 per cent of the reserves of chlorpicrin and phosgene each year is one of the specific suggestions to this end which would permit co-operation of the Chemical Warfare Service with the dye interests. Numerous other means of co-operation will suggest themselves also.

It is certain that these efforts will afford a most encouraging element upon which to base our support of the needed increases in financial backing for the C.W.S. Congress will doubtless be asked to appropriate considerable sums next winter to augment the facilities for additional research work needed. If the chemists diligently study the opportunities for peace-time service of this branch of our military organization they can most enthusiastically and effectively support these requests. Our profession is signally recognized by the maintenance of this branch of the Army and it is a responsibility of the profession to support the Service accordingly. The proposed advisory committee of chemists which the American Chemical Society is to appoint to work with the C.W.S. will be one medium through which our support may be afforded, but an individual responsibility of chemists is equally important, especia'ly wherever there is opportunity for industrial application of or co-operation in C.W.S. activities.

Readers' Views and Comments

College and University Finances

To the Editor of Chemical & Metallurgical Engineering

SIR:—All our educational institutions have recently felt the pinch of limited resources, and many have made strenuous efforts to raise large endowments, intended for the most part to increase the salaries of the teaching staff.

This whole idea is essentially undemocratic and un-American, so long as the colleges and universities do not make a charge for tuition equal to its actual cost. As long as this condition exists, increased endowments to make up the deficit are in the nature of charity and tend to pauperize the beneficiaries—i. e., the students or their parents paying their tuition.

At the present time no one of these institutions has stamina sufficient to charge for tuition its actual cost. Rich and poor alike are charged the same, an average of about one-half the actual cost. Neither the rich nor the poor are informed as to the actual cost being double the price charged, and the rich are not even invited to pay the cost.

No one with the true American spirit wishes to educate his children at less than its cost, if he is able to pay the cost. But our universities proceed on the tacit assumption that the preceding statement is untrue, that the American parent always wishes to get the education at as low a figure as possible and to avail himself as far as possible of the endowment funds which charitably disposed persons have contributed to assist the colleges in their work. I am firmly convinced that this tacit assumption is the one that is totally false; that the American spirit recoils from accepting charity and prefers to pay the proper price and preserve its self-respect.

One result of the charge for tuition being placed at only a fraction of its actual cost is that the more students in attendance the greater is the strain on the institution's finances, the more endowment is needed to meet the deficit, and, in general, the more the institution has to plead poverty and to cut to the lowest possible figure all expenditures, such as salaries of the teaching staff, etc. Our institutions being of late notoriously overcrowded, it results that the greatest sufferers are the teaching force, the restricting of whose salaries is the chief avenue open for economy. We can say with almost absolute truth that rich men's children are being educated in our colleges at half price largely at the expense of the teaching staff, whose salaries must be restricted to the minimum if the institution is to make ends meet.

Is the proper remedy for this condition to appeal to wealthy patrons generously to donate large endowments whose income shall go to increasing salaries of the teachers? Is this not adding insult to injury? It surely should appeal to level-headed business men rather to solve the question by making the charge for tuition its cost, which would then be paid by all able to pay it. In this way, the parents do not receive charity from the institution's endowment in the form of tuition for their children at half its cost; neither are the teaching staff receiving living wages from endowment provided by generous and wealthy patrons.

What is needed is a return to normal, healthy business methods in the running of our higher educational institutions, and to give the independent American the chance to pay for what he is getting. Departure from such a principle causes most lamentable confusion, plainly evident to those who will study the subject dispassionately and sanely.

The writer is a university professor, receiving as salary only a fraction of what his services would command industrially; the same is true of my assistants. The university could pay me and my assistants increased and more proper salaries if full cost of tuition were paid for those students whose parents are able to pay it. Out of whose pockets, then, is this deficit coming? It is a fallacy to consider it as coming from endowment; it really is extracted, under present circumstances, from the salaries of the teaching staff. The well-to-do parents should be given the opportunity to right this wrong, and the proper remedy is to make the charge for tuition equal to its cost.

The only valid argument against this innovation is that it will prevent large numbers of worthy students from getting an education because of inability to pay the cost. It may be admitted at once that under the proposed new charges, more students will be unable to pay the charge than at present. But that is not an insuperable difficulty. At present, no worthy student who shows good scholarship is turned away for inability to pay tuition. He either gets a scholarship, intended to help just such men, or else he is granted "deferred tuition" for a half, a quarter, or all the tuition charge. This means that he pays what he can, and the college lends him the rest, he promising to repay it, without interest, as soon after graduation as he is able. This is the right and proper use of endowment funds; to help those who need help, and not foolishly to waste it on those who need no help and can pay the full cost of tuition.

Adoption of the proposal to make the tuition charge the full cost of tuition would liberate endowment funds now misapplied and turn them into the proper channel of assistance to worthy students not able to pay the cost. No worthy student need then be turned away, there are all grades of financial ability and disability among students; no one would be asked to pay more than the mere cost, no matter how rich he or his parents. For the fraction unable to meet this very reasonable requirement, the endowment funds should be wisely appropriated, so as to make up the difference between cost and the students' ability to pay. Most of this would come back to the institution a few years after the recipient graduated, and thus the endowment funds would not be diverted but largely returned.

Concrete application of this abstract principle will show that it is practicable and financially sound, as well as being ethically far superior to the present antiquated and absurd system. Adoption of the system advocated will put endowment to work in its proper channels,

will increase the self-respect of the students, who will feel that they are not objects of charity when the cost of their tuition is being paid, will increase the self-respect of the American parent who pays the full cost of his children's education, will enlighten the financial burdens of the institution by making income more nearly proportional to expenses, and will enable the institution to apply the sums saved to the increase of salaries of the teaching force, where they properly belong, and whence they are at present being unwisely and unnecessarily diverted.

Are endowments made to higher educational institutions intended to help educate well-to-do people's sons at half cost, or to help educate those unable to pay the simple cost of their education? Should the compensation of the teaching staff be restricted to less than proper living salaries to make it possible to educate well-to-do people's children at half the cost?

Lehigh University,   JOSEPH W. RICHARDS.
South Bethlehem, Pa.

Massachusetts Institute of Technology School of Chemical Engineering Practice

To the Editor of Chemical & Metallurgical Engineering

SIR:—The School of Chemical Engineering Practice of the Massachusetts Institute of Technology, which was started in 1916-17 and then discontinued on account of the war, has been reopened. The work of this school is part of a 5-yr. course in chemical engineering offered by the Institute and consists of twenty-four weeks' field work at three chemical engineering practice stations. These stations are located at Bangor, Me., Everett, Mass., and Buffalo, N. Y. The plants co-operating with the Institute in this important educational work are the Eastern Manufacturing Co., manufacturing electrolytic bleach, sulphite pulp and writing papers; the Penobscot Chemical Fibre Co., O!dtown, Me., manufacturing soda pulp; the Revere Sugar Refinery, Charlestown, Mass.; the Merrimac Chemical Co., Everett, Mass., producing heavy chemicals; the Boston Rubber Shoe Co., Malden, Mass., the Lackawanna Steel Co., Buffalo, N. Y., and the Larkin Co., Buffalo, N. Y., manufacturer of soap, etc.

In the practice school the students study the various unit chemical operations such as filtration, evaporation, combustion, etc., on full-scale apparatus and under practical working conditions. Sometimes this is accomplished by actually working with the operating men, and at other times by running a full-scale test to determine either the efficiency of the equipment or process, or to find optimum conditions of operation. Such tests are always carried out under regular factory conditions without interfering with the quality or quantity of the output and are along lines which are of interest to the co-operating companies. Work at the Bangor station includes investigations into the production of chlorine and bleach, the absorption of SO_2 in the manufacture of bisulphite liquor, the efficiency of quadruple effects evaporating caustic soda solutions, etc. Work of similar character but along different lines is carried out at the other stations.

The students will complete their work in the practice school at the end of December, and will then return to the Institute for two terms of advanced study. This advanced work is wholly elective and enables the student to specialize in that line of chemistry or engineering in which he is most interested. In the choice of courses and in the viewpoint toward this advanced work, the student will be greatly benefited by the practical plant experience he receives in the field work of the practice school.

There is one important difference between the School of Chemical Engineering Practice and other co-operative engineering courses, where the student is regularly employed for part of his time in the factory, and the remainder is spent in class room and laboratory work at the college or university. This difference lies in the fact that instead of being on routine factory production work, as is customary in such courses, the student in the School of Chemical Engineering Practice is always under the direct charge of a resident faculty member at each station and the student's work is so planned that he shall obtain the greatest possible benefit from the time spent in the plant.

Two matters which have occupied considerable attention in scientific and engineering circles are the education of future engineers and the establishment of closer relationship between the work of the university and that of industry. In the School of Chemical Engineering Practice, progress along both of these lines has been made, and a great forward step taken in the sound, rational education of the Chemical Engineer.

Cambridge, Mass.   R. T. HASLAM,
                                                       Director.

Self-Contained Engineering Journals

To the Editor of Chemical & Metallurgical Engineering

SIR:—With so many highly-specialized engineering journals in the field, a reader who wishes to keep in general touch with engineering has to do as Thomas Edison does and read them all. A recent magazine article (was it in *Engineering and Contracting?*) reported that Edison reads regularly fifty-two technical periodicals. Even then the average reader is bound to miss much that he would like to see, and he really cannot expect anything else. The best that he can do is to find the majority of the best articles that discuss his particular hobbies.

For instance, a reader interested in the cyanide process for gold ores can find suggestive articles in *Engineering and Mining Journal, Mining and Scientific Press*, CHEMICAL & METALLURGICAL ENGINEERING, and several of the publications of the chemical societies. Of course, a member of the staff of any one of these periodicals will assert that his particular paper publishes all that is worth seeing, but that is not true. Each paper has its merits.

The point I am getting at is, Why do not the editors of the various engineering journals acknowledge more often that such and such a paper has printed an unusually good article on this or that? The readers undoubtedly would be glad to hear about it, and would credit the editor for his fairness and generosity. Most engineers subscribe to only one technical journal, and would be glad to know from an editorial note that an unusually good article on some particular subject has appeared in another paper, which they could refer to at a library.

In other words, are not engineering journals too self-contained? Are not the editors too chary of praising or acknowledging or even criticizing (good criticism helps enormously) the achievements of other journals? American engineering journals are, if anything, too highly specialized, but why can they not make up for it by passing the news around of something worth while in the other papers?

                                                  P. B. McDONALD,
New York University,   Assistant Professor of English.
College of Engineering.

Synthetic Production of Hydrocarbon Fuels

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with great interest Edward G. Acheson's letter in your issue of Aug. 18, p. 268, and while disclaiming much knowledge of chemistry outside of my business, yet, in view of what has been accomplished, the synthetic production of hydrocarbon fuels does not seem impossible.

This leads to the thought that should synthetic hydrocarbon be produced it is more than likely that the fuel will be a simple compound, and not a conglomerate of a dozen hydrocarbons such as we now obtain from the crude, each with its own boiling point and other individual peculiarities that in combination produce most of our troubles with the internal combustion motor.

For example, should it be possible to produce pure pentane, the designing of carburetors would at once be a simple matter, and nine-tenths of our motor troubles would vanish.

I am also led to think that Mr. Acheson is perhaps the one man in this age who by training, accomplishments, physical resources and financial independence is best equipped to tackle the problem.

President and Chemist,   EDWARD T. BIRDSALL, M.E.
The Parker Rust Proof Co.,
Cleveland, Ohio.

Nitrogen Fixation in the Soil by Inoculation

To the Editor of Chemical & Metallurgical Engineering

SIR:—I am firmly convinced that soils may be profitably inoculated by azotobacter and possibly other large-celled organisms, in order to provide for the non-symbiotic fixation of nitrogen under adequate control, and believe that in time a method will be developed which will economically take the place of commercial nitrogenous fertilizers. However, we have not continued our investigations along this line since the publication of Bulletin 45, but are in hopes of doing so in the near future.

This station does not recommend the purchase of commercial nitrogen for Iowa conditions, believing that by a judicious use of inoculated legume and the proper handling of farm manures the supply may be made adequate. I believe, however, that by a further inoculation with azotobacter at some period during the rotation the excess carbohydrates in the soil may be utilized by these organisms to produce even greater quantities of nitrogen than is produced at present by the symbiotic organisms.   PAUL EMERSON,

Assistant Chief in Soil Bacteriology.
Iowa State College of Agriculture and Mechanical Arts,
Ames, Iowa.

Resistance Between Cup and Lip

To the Editor of Chemical & Metallurgical Engineering

SIR:—Your editorial on "Resistance Between Cup and Lip" hits the spot. Several years ago while in Szechuen, China, I saw the wonderful possibilities of a complete industrial development of a backward country and prepared a preliminary survey and suggested plan. American manufacturers would not even consider co-operating with us in the plan; others wanted knowledge of the markets to be sent to them but were not willing to supply any funds to get the needed information.

A company organized to get the information and digest it, proposing same to the right parties, has a big, useful and most interesting field of opportunity.

Middlebury, Conn.   H. K. RICHARDSON.

Phosphate Rock Deposits in Morocco

By James C. Martin

THE large and growing demand for phosphate rock and superphosphate fertilizer in Europe justifies the keen interest with which American producers have received rumors of the discovery of additional large deposits of phosphate rock in western Morocco. A shortage of shipping in the Mediterranean has recently prevented the producers of rock phosphate in Tunis and Algeria from shipping from abroad all they could deliver to the docks, but the quantity thus delivered is at best insufficient to supply the present European need. Accordingly, though the discovery of vast deposits of rock phosphate may not afford a means of supplying the demand at once, the adequate working of the deposits and the marketing of their output will furnish additional competition with the American product.

For the information of Americans who are interested in the phosphate industry the following data regarding the deposits in Morocco have been compiled by the Foreign Mineral Section of the United States Geological Survey, Department of the Interior.

France has a mild form of monopoly over the output in Tunis and Algeria and allocates a part of each year's output to other European countries in rough proportion to their estimated needs, taking in exchange other materials required for the manufacture of superphosphate, such as coal, pyrite and sulphur. In addition to her deposits of phosphate in Algeria and Tunis, France controls vast undeveloped deposits in Morocco. These deposits are said to be extremely rich, containing hundreds of millions of tons, worth billions of dollars to France and capable of furnishing considerable aid in rehabilitating her war-depleted treasury. If current reports concerning the high grade and great extent of these deposits are true, France will be in a dominant position in supplying Europe with phosphatic fertilizer. Her allocation of African phosphate in 1919 and 1920 to the countries in Europe and the requirements of those countries are shown in the following table, but on account of the lack of vessels the quantities actually delivered to many countries in 1919 were only fractions of the quantities allocated.

PHOSPHATE REQUIRED IN EUROPE IN 1919 AND 1920 AND FRENCH ALLOCATION OF AFRICAN ROCK FOR THOSE YEARS*

Country	Required Tons	Per Cent†	Allocated Tons	Per Cent†	Per Cent of requirements
France	1,100,000	42	700,000	50	64
Italy	600,000	23	355,000	25	59
England	400,000	15	247,600	18	62
Spain	200,000	8	73,600	5	37
Belgium	100,000	4	3,600		4
Netherlands	100,000	4			
Portugal	50,000	2	14,700	1	29
Scandinavia	40,000	2			....
Switzerland	10,000	....	5,500	....	....
	2,600,000		1,400,000		54

*Adapted in part from *American Fertilizer*, vol. 52 (1920) p. 140.
†Nearest whole number.

The intensification of agriculture in the countries recently at war will create a large demand for phosphate, and the exploitation of the Moroccan deposits will undoubtedly disturb the American phosphate industry. At present, however, European consumers cannot obtain more than a fraction of the phosphate they need from America.

The Flow of Oil in Pipes—I

A General Method for Determining the Friction Loss of Any Liquid From Its Saybolt Viscosity; With Tables for Pipes From One to Six Inches in Diameter

By ARTHUR C. PRESTON

THE following discussion of the flow of viscous liquids in pipes aims to develop a method for determining friction loss as a function of the viscosity and density of the liquid. The viscosity may be taken either in absolute units or as the time of flow through any commercial instrument which can be accurately calibrated with respect to the absolute unit. The appended tables are based on viscosity-seconds as measured by the Saybolt Universal Viscosimeter, because that is the standard of viscosity measurement most frequently employed in commercial practice, and it is thought that in this form the tables will be found most generally useful.

The present discussion relates primarily to the flow of mineral oils, but the method is general and may be applied to any other fluid.

The most accurate and important part of the experimental data on which these conclusions rest is the work of other investigators, although it is corroborated in all essential points by the results of a fairly extensive series of experiments on the flow of oil in wrought iron pipes which the writer carried out several years ago at the University of Colorado. The writer's part in the present instance has been chiefly to correlate and adapt the work of others, so as to put the whole in familiar and convenient form for use in general engineering design.

Factors Affecting Rate of Flow of Liquids Through Pipes

The rate of flow of a liquid moving through a pipe under a gravity head is influenced primarily by three characteristics of the liquid itself—namely, the density, which supplies the pressure producing flow; the viscosity, which retards flow; and inertia, which under certain conditions manifests itself in the dissipation of energy by the collision of eddying particles. These three constitute what may be called the internal group of factors affecting flow; the other factors, such as the diameter, length and roughness of the pipe, and the amount of the gravity head, may be called the external group; and the latter, although of great importance in their bearing on the final resultant flow, are secondary in the order of consideration of the problem as a whole. Any or all of the external factors may in practice be varied at will, and the resultant flow will respond to these variations according to laws which may be experimentally determined and analytically stated; but underlying all the observed phenomena are the fundamental limitations to flow imposed by those inherent properties of the liquid which have been described as the internal group.

It is essential to grasp this distinction clearly at the outset of any attempt to consider the general problem of liquid flow, because it is entirely lost sight of in the account of hydraulic theory which is commonly made available for engineering study and reference. In the presentation of that theory the factors of the internal group are usually entirely neglected. They are left out of consideration because they are nearly constant for water at ordinary temperatures, and the laws deduced from hydraulic experiment are only those which exhibit the influence of the external group. Hydraulic flow is a very special case of liquid flow; hydraulic theory is not at all an exposition of general liquid theory, but applies only to such liquids as have the same density and viscosity (or more accurately the same ratio of density to viscosity) as water; and indeed the laws as usually stated apply only to a limited range of velocity even for such a liquid.

Hydraulic tables do not furnish a satisfactory basis for estimating the flow of any other liquid, even when the internal characteristics of the latter are known; but when the general solution for the problem of liquid flow is obtained it takes the place of hydraulic formulæ and gives the same results, simply by substituting in the general formula the physical dimensions of the pipe and the values for the particular density and viscosity of water.

Data From Research Investigations Applied in Practical Form

Experimental work leading to this general solution has been carried on in recent years by numerous investigators, influenced greatly, no doubt, by the rapid development in the use of mineral oils in the industries and the consequent need of rational methods for designing oil piping. Out of a number of valuable researches which have been published, each contributing to some phase of the question, two in particular have seemed to cover the ground most satisfactorily; these are two series of researches on the flow of air, water and oil in pipes, conducted and published by the British National Physical Laboratory,[1] which have not had wide currency in this country. Just after the publication of these came a third work, the standardization of the Saybolt Universal Viscosimeter, by the Bureau of Standards,[2] which taken in conjunction with the theory developed in the two first mentioned has made it possible to adapt that theory to practical form for the use of engineering designers. From these sources, whose conclusions are confirmed by the work of many other experimenters, it has been possible to compile the tables which are presented herewith, showing the discharge for a given pipe and head, for liquids of any density and viscosity, simply by reference to the time

[1] Collected Researches, National Physical Laboratory, Teddington, England, Stanton and Pannell, vol. 11, 1914, and Pannell and Higgins, vol. 13, 1916.

[2] Winslow H. Herschel, Bureau of Standards, Technologic Paper No. 112, Washington, 1919.

of flow through a standard commercial viscosimeter. It is believed that the first published tables of this form were those offered by the writer in his report of the work done at the University of Colorado, which are now superseded by the more accurate tables given in this article.

The method of developing the process was briefly as follows:

It had been demonstrated[1] that in a given pipe at constant velocity, the head lost in friction is the same for all liquids which have the same ratio of density to absolute viscosity. This was substantiated by experiments on large and small pipes, at high and low velocities, with fluids of such varying viscosity as air, water and oil. The general relation between these factors had been derived, so that only a knowledge of the values of density and viscosity was required to make it available for the solution of any given problem.

Second, the standardized Saybolt Universal Viscosimeter had been calibrated[2] so that it could be used as a means of determining these values, and this work had shown that liquids having the same ratio of density to absolute viscosity have the same time of flow through the Saybolt instrument.

As a result of the foregoing, the conclusion is drawn that liquids of equal Saybolt viscosity have equal pipe friction losses, and means are given for computing friction loss from Saybolt viscosity as primary data. To this are appended tables, which have been computed for convenience of reference.

Kinematic and Absolute Viscosity

Viscosity may be defined loosely as the internal friction of a moving liquid. In set terms, it is the force required to move a plane surface of unit area past another at unit distance, at unit rate of speed, the space between being filled with the viscous liquid. Various means may be devised for measuring this force; as, for instance, by dragging a solid body with flat surfaces through the liquid and noting the pull exerted; but the form of instrument most frequently used consists of a tube of narrow bore and relatively great length, through which the liquid moves under a small gravity head at low velocity, so as to prevent eddying. The moving body may be considered as made up of an infinite number of concentric cylindrical films of infinitesimal thickness, all moving forward along the axis of the tube. The outermost film wets the wall of the tube and sticks fast there; the next film slips or shears over the first at a rate which depends on the viscous resistance of the fluid; and so on to the center filament, where the motion is fastest. The resistance to slipping of one film surface over another, which corresponds in some degree to the phenomenon of friction between the surfaces of solid bodies, is the measure of the viscosity of the liquid. It is evaluated by integrating the sum of all the resistances from the circumference to the center of the tube, and equating this sum to the pressure due to the gravity head, less the velocity head, since all the pressure, except the small amount which appears as kinetic energy, was used up in overcoming the slippage resistance and consequently is equivalent thereto. The method will be found fully explained by Archbutt and Deeley;[3] and is the basis of the design of the Saybolt and similar flow-

[1]Archbutt and Deeley, "Lubrication and Lubricants," Griffin & Co., London.

type instruments. The mathematical expression for the absolute viscosity is

$$\mu = \frac{\rho g r^2 h}{8 v l} \tag{1}$$

Where ρ = density in grams per c.c., or pounds per cu.ft.

g = gravity = 981 cm., or 32.2 ft. per sec. per sec.

r = radius of tube in centimeters or feet

h = head in centimeters or feet

v = average velocity of flow in centimeters or feet per second

l = length of tube in centimeters or feet.

This gives μ, the coefficient of absolute viscosity, in dynes per sq.cm. or in poundals per sq.ft., according to the system of measures employed. The equation applies only to the condition of steady or non-eddying flow.

The conversion factor between the two ways of expressing absolute viscosity is 14.9, by which the c.g.s. value must be divided to give the English equivalent. For most purposes it is more convenient to deal with the ratio, $\frac{\mu}{\rho}$, which is called the kinematic viscosity and is the quantity measured by commercial flow-type viscosimeters. The conversion factor for kinematic viscosity is 929.03, by which the c.g.s. value must be divided. The c.g.s. system certainly is more convenient for laboratory use, and is adopted in most of the investigation and literature of viscosity; but in the present case it is necessary to use the English units in order that the theory as developed may be applied directly to our everyday practice of making measurements in that system.

Eddying Flow

From the form of equation (1) it may be seen that for the condition of non-eddying flow, the relations of the governing factors are very simple; and this kind of flow characterizes many cases of practical interest, particularly with small pipes or with liquids of high viscosity. Since the rate of variation of all these quantities is linear, it follows that, if the friction loss for a given combination of factors be known, the loss due to any variation in these factors may be deduced by simple proportion, throughout the range in which the equation holds good; or, the loss for any case may be determined by substituting the proper values for viscosity and density in the equation. Further, it is seen that when the pipe dimensions and velocity are constant, friction losses are equal for all liquids having the same kinematic viscosity. Now it will be shown later on that liquids of equal kinematic viscosity have the same time of flow through a Saybolt or other viscosimeter of similar type; from which it follows that liquids of equal Saybolt viscosity have equal friction losses, at least throughout the range of velocity in which flow is steady, and, as will be demonstrated, for all higher velocities also.

This relation then might have been of considerable use to pipe line designers in the past, but for two principal facts; first, that designers rarely have means for determining absolute viscosity, and even if they know the Saybolt or other commercial viscosity of the liquid with which they deal, they do not know how to convert it to units of absolute viscosity; second, that equation

(1) applies only to a limited range of low velocities, and breaks down entirely at the point where eddying begins, leaving the friction loss at all higher velocities to be determined by methods which until recently were not thoroughly studied or understood.

If a liquid be set flowing in a pipe at a low but steadily increasing velocity, the phenomena at first are those of the steady flow which has just been described, the increase of friction head being linear or as the first power of the velocity. When a certain rate of flow is reached a sudden change occurs, and equation (1) no longer holds. This new régime begins with a brief period of uncertain flow, during which friction loss increases at a much greater but variable rate, until when another definite velocity is reached a second sudden change occurs, and friction loss thereafter increases regularly, but more slowly than in the preceding stage. If the smoothness of the pipe is equivalent to that of drawn piping, the rate of increase is approximately as the 1.74 power of the velocity. This is the régime of eddy flow.

Critical and Post-Critical Velocity

The point at which the first change occurs is quite definitely fixed by the relations of viscosity, density and diameter of pipe. It is determined by the so-called Reynolds criterion,

$$\frac{r \rho d}{\mu} = R \qquad (2)$$

where R is a number which undoubtedly varies somewhat with the roughness of the pipe, but which for smooth drawn pipe or tubing is quite accurately equal to 2,050. The point at which the second change appears is fixed in the same way by another value of the same expression, which for want of a better name may be called the post-criterion, where R for the same kind of pipe equals 2,900. The velocity at the first point is called the critical velocity, and that at the second point may be called the post-critical velocity.

The explanation of these changes, as was developed by the work of Osborne Reynolds,[1] is that at the critical velocity the steady or stream-line flow of concentric cylinders sliding over each other is broken up, and the particles of liquid begin to eddy and whirl, using up in the friction and impact of collision the extra head which makes its appearance at that point.

Mathematical Analysis of B. N. P. Lab. Data

A graphic illustration of the relation of velocity to friction head, embodying the phenomena described in the foregoing paragraphs, is given in Fig. 1, in which part (a) has been plotted directly from the data sheets in the published report from the National Physical Laboratory, for an oil of kinematic viscosity 0.00011474 —about 62 seconds Saybolt—flowing in a 3-in. drawn steel pipe. The friction head in feet per hundred feet of pipe is plotted against the velocity in feet per second, by the familiar method of logarithmic plotting—that is, not the quantities themselves but their logarithms are plotted against each other. The points are found to fall on straight lines, whose slopes are the exponents of the variables in the equations which express the relation of h and v; for if m be the slope of the line and C its intercept on the axis of abscissas, then $\log h = m$ ($\log v - C$). Taking C as the logarithm of some constant A,

[1]*Phil. Trans. Royal Soc.*, vol. 174, p. 935 (1883); vol. 186A, p. 123 (1895).

$$\text{Log } h = m \ (\log v - \log A)\ ; \text{ or,}$$

$$h = \left(\frac{v}{A}\right)^m = K v^m \qquad (3)$$

so that each of the three broken lines of which the graph is composed represents a condition of flow in which h varies as some power, m, of v. The lower part of the graph represents the region of steady flow, and the slope of the line is 1.0, confirming the statement that the variation in this region is linear, or as the first power. The upper part of the graph represents the region of eddy flow, where the slope of the line is 1.74, and the friction head varies as this power of the velocity. The intermediate line represents the region of uncertain flow, where the points as plotted do not suffice to determine the slope of the line, and where in fact successive experimental determinations cannot be made to agree. The line which has been drawn as the average locus of points in this region runs from the value of log v which makes $\frac{r \rho d}{\mu} = 2{,}050$ (Reynolds criterion) to that which makes it equal to 2,900; these values of R are mean values from all the experiments
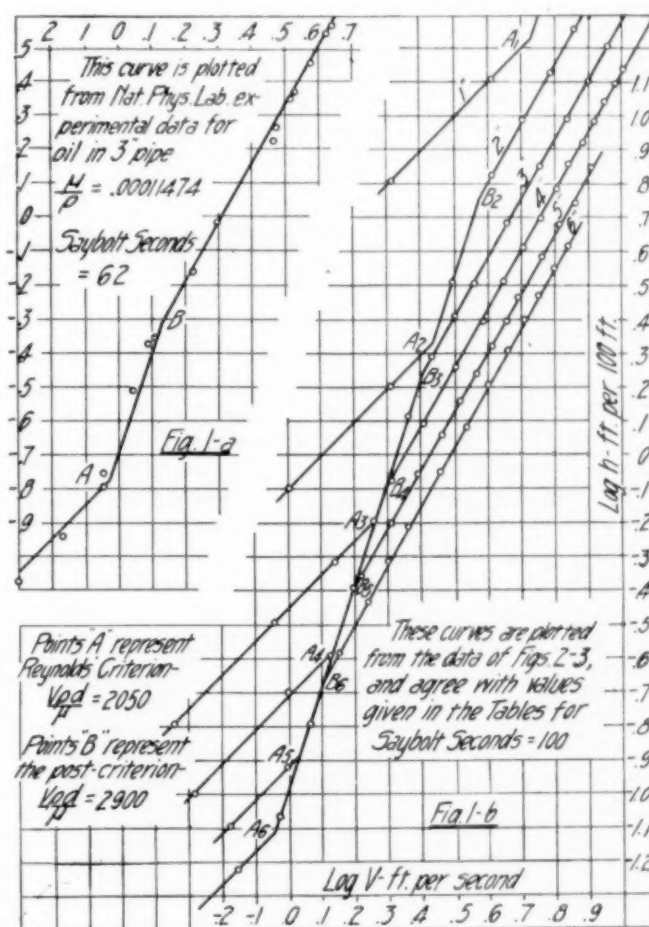
FIG. 1.   RELATION OF VELOCITY TO FRICTION HEAD

on which the report is based, and they make the slope of the line equal to 3.0, so that h in this region varies approximately as the cube of v. It must be remembered that the variation here really is indeterminate, the flow being apparently unstable. The matter is of little practical importance because the uncertainty extends only over the short range from the critical velocity to a velocity about 1.41 times as great; the important matter

is to know that the friction head will vary as the first power of the velocity below the point where $R = 2,050$, and as the 1.74 power above the point where $R = 2,900$.

In Reynolds' opinion, the fact that these changes occur suddenly instead of developing gradually indicates that the whole régime of steady flow is unstable. From this point of view we may suppose that when the break does come, the friction head increases in the erratic and rapid manner noted in order to gain the régime of eddy flow as quickly as possible; attaining this point, as we have seen, by the time the velocity has increased sufficiently to make $R = 2,900$.

CALCULATION OF FRICTION HEAD

We are now in possession of a crude method for calculating the friction loss of any liquid in pipes of smoothness equal to that of drawn piping, provided we can find means to determine the kinematic viscosity of the liquid—that is, the ratio $\frac{\mu}{\rho}$, for substitution in the foregoing formulæ. We can compute, from equation (2), the value of v_1 which makes $R = 2,050$. Then from equation (1) we can find the value of the corresponding h_1, and we know that for all lower velocities the value of h decreases directly as the velocity, or

$$h_1/h_0 = v_1/v_0 \qquad (4)$$

Next we may compute the value v_2 which makes $R = 2,900$, and we know that

$$h_2/h_1 = v_2^2/v_1^2 \qquad (5)$$

The same ratio of variation holds for velocities between v_1 and v_2. Finally, for any higher velocity v_x we know that

$$h_x/h_2 = v_x^{1.74}/v_2^{1.74} \qquad (6)$$

This would indeed be a bungling method, and liable to error both from the magnification of slight inaccuracies in the work and from the fact that the last exponent does not continue equal to 1.74 for the very highest velocities, nor for great changes in roughness, although it is sensibly so for all cases of practical interest. But it is worth while to note the possibilities of this method because it really offers a more complete analysis of the problem than the simpler and more convenient process to be described later, on which the tables are based.

RELATIONS OF SAYBOLT TO KINEMATIC VISCOSITY

From what has been said about the determination of viscosity, it may be seen that any long pipe, even a pipe in industrial service, could be used as a viscosimeter if observations could be made on it with sufficient accuracy, the velocity being kept low enough to avoid eddying. For physical laboratory use this condition is obtained with tubes of capillary fineness, and correspondingly refined methods of observation; while in the commercial laboratory instruments are used which are somewhat simpler in construction, although based on the same principle, such as the Engler, Redwood and Saybolt Universal, the latter being the one most in use in the United States.

The Saybolt instrument consists essentially of a smooth vertical efflux tube, 1.225 cm. long and 0.1765 cm. in diameter, through which it is intended that steady or non-eddying flow shall take place. This tube is surmounted by a vertical cylindrical container, 2.975 cm. in diameter and about 9.7 cm. long, connected to the upper end of the efflux tube by a converging section about 1.575 cm. long. The upper container holds a little more than 70 c.c. and the whole is surrounded by a water bath to maintain a constant temperature of the liquid in the container. The determination consists of filling the container with the liquid under investigation, and letting 60 c.c. run out through the tube into a graduated vial, noting the time of flow required in seconds.

Referring to equation (1), we see that a constant average head, h, and constant values of r and l are assured by the construction of the instrument, and the time of flow of course is proportional to v; consequently if the flow were truly steady, the kinematic viscosity, $\frac{\mu}{\rho}$, would be truly proportional to the time of flow or so-called Saybolt seconds. But the instrument is faulty, in that for liquids of low viscosity the flow is not steady, but eddying, so that the Saybolt seconds are no indication of true viscosity. There are also other sources of error, chief of which is the resistance to flow offered by the surface tension of the drop as it forms on the end of the efflux tube. The kinetic energy or velocity head of the flowing liquid also ought to be allowed for and subtracted from the total average head. The net effect of these and other inaccuracies of the method is to make the time of outflow for liquids of low viscosity enormously greater than it would be if the flow were steady, and entirely out of proportion to the true viscosity.

Prof. Flowers[3] tells us that in designing the original Saybolt instrument it was intended that the length and diameter of the tube should be such as to assure the condition of steady flow for water, which was to be used as a standard. This may have been true of the form of the instrument first used, but it is not true of the present, called the Universal, instrument. For this the time of flow of water is about 31 seconds, while the errors above described are serious for all liquids up to those which have a Saybolt time of about 250 seconds. The comparison with water, therefore, should never be looked upon as having any relation to the true viscosity of another liquid, and is in no way an indication of the friction loss to be expected in handling that liquid in pipes. When the time of flow is above 250, however, the errors are not so serious and the Saybolt seconds vary almost exactly as the kinematic viscosity.

CALIBRATION OF SAYBOLT VISCOSIMETER

The only way, then, to get true viscosity readings from a Saybolt viscosimeter is to calibrate the instrument by the use of liquids of known viscosity previously determined by physical laboratory apparatus; and this calibration will apply only to the particular instrument for which it is made, because not all of these instruments are of accurately similar dimensions. To overcome this difficulty, the Bureau of Standards has published, in the work referred to, an account of an agreement with Mr. Saybolt whereby certain definite dimensions are hereafter to be used and considered as characterizing the standardized Saybolt Universal Viscosimeter; and the same paper gives the calibration of this instrument, by means of which the

[3]American Society for Testing Materials, *Proceedings*, vol. 14, 1914, p. 565.
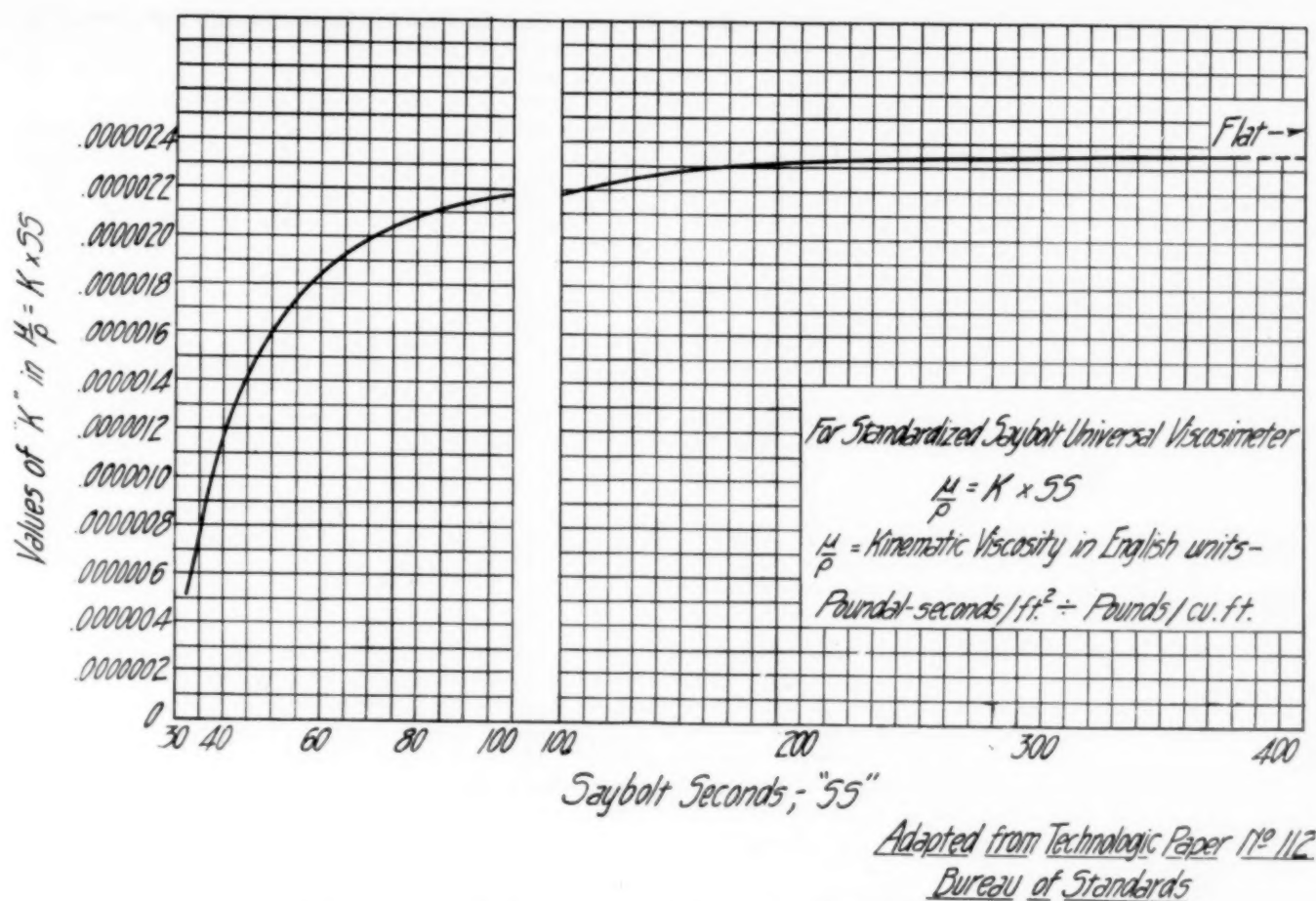
FIG. 2. RELATION BETWEEN SAYBOLT SECONDS AND KINEMATIC VISCOSITIES

kinematic viscosity of a liquid may be known from its Saybolt seconds; thus providing us with a practical means of completing the method of equations (1), (4), (5) and (6) for computing pipe friction loss as a function of the kinematic viscosity.

In the publication of the Bureau of Standards, the calibration is given as an equation and also in the form of a table, the values being in c.g.s. units. In Fig. 2 of the present paper the table is put into graphic form, the values being converted to English units. The curve is used by entering with the Saybolt seconds, from which a conversion factor is found, by which the Saybolt seconds must be multiplied to give the kinematic viscosity.

It will be seen that this work is of the greatest value in investigations of the kind with which we are concerned. The determination by the Saybolt instrument is very easily made; the refiner or seller of mineral oils can always give the Saybolt viscosity at any temperature which the user may assume as governing his particular case. In developing the method for computing pipe friction loss and compiling the appended tables, this calibration has been assumed to apply to all Universal instruments. In making this assumption the fact is not lost sight of that it really applies only to a standardized instrument; but as the standard dimensions and calibration taken were the average for several instruments investigated, it is believed that the error will not be greater than is permissible in computations of liquid flow, and that the convenience and usefulness of having a definite and general means for calculating friction loss will justify the slight degree of approximation involved.

It has been stated above that the method of equations (1), (4), (5) and (6) was developed more for the sake of analyzing the nature of friction loss than as a rule to be followed in practical designing. A more convenient way of exhibiting the same results, although it does not show the fundamental relations of the variables so clearly, is given in the work of the National Physical Laboratory. These experiments were begun for the purpose of determining the frictional resistance of the atmosphere to the passage of an airplane body, the method used being the reverse process of passing air through smooth-walled pipes. The results obtained were so suggestive that the investigations were extended to include a study of water and of oil; then a second series of experiments on the friction resistance of fuel oils carried out for the British Admiralty gave similar results, and finally all available recorded researches on the subject of fluid friction were re-computed and recast in the same form, and were found to be consistent with the rest. The whole investigation covered the flow of air in pipes from 0.361 to 20.0 cm. diameter; of water from 0.361 to 28.5 cm.; and of oil from 3 to 5 in., over a very great range of velocities, all in smooth-drawn brass or steel pipes. The conclusion to which all this work led was that for equal values of $\frac{v \rho d}{\mu}$, values of the friction factor f are always equal in the well-known Fanning formula

$$h = f \frac{l v^2}{d 2g} \qquad (7)$$

The curve of Fig. 3 is plotted with values of $\frac{v \rho d}{\mu}$ as abscissas and values of f as ordinates. No attempt

is made to state the relation in mathematical form; it is simply to be scaled from the curve as drawn.

The significance of this is that since for a given velocity and pipe diameter all liquids of equal kinematic viscosity have equal values of $\frac{v\rho d}{\mu}$ and consequently equal values of f, it follows that they have equal values of friction head h. But it has been shown that liquids of the same kinematic viscosity have equal Saybolt seconds; so that it must be concluded that liquids of equal Saybolt viscosity always have the same loss of friction head when flowing at the same velocity in the same pipe. This is a conclusion of very great interest and importance.

It has always seemed probable, from general considerations, that such a relation must exist, but apparently it never before was experimentally and satis-

find the value of f for the desired v and d from Fig. 3; completing the calculation of h by means of the Fanning equation (7). It was by this method that the tables given with this article were computed.

Partly as a matter of interest, and partly as a means of checking up and locating discrepancies, these tables were plotted by the logarithmic method of (a) Fig. 1, and one of the resulting diagrams is shown in (b) of the same figure for a Saybolt viscosity of 100, with pipe diameters of from 1 to 6 in. The plotted points fall very accurately on lines of slope 1.74 above the post-critical velocity, and on slopes of 3 and 1 in the two other régimes of lower velocities. The source of the breaks at critical and post-critical points is clearly seen in Fig. 3, for in that curve, which is the direct record of experiment, it is found that steady flow changes to uncertain flow at the Reynolds criterion,
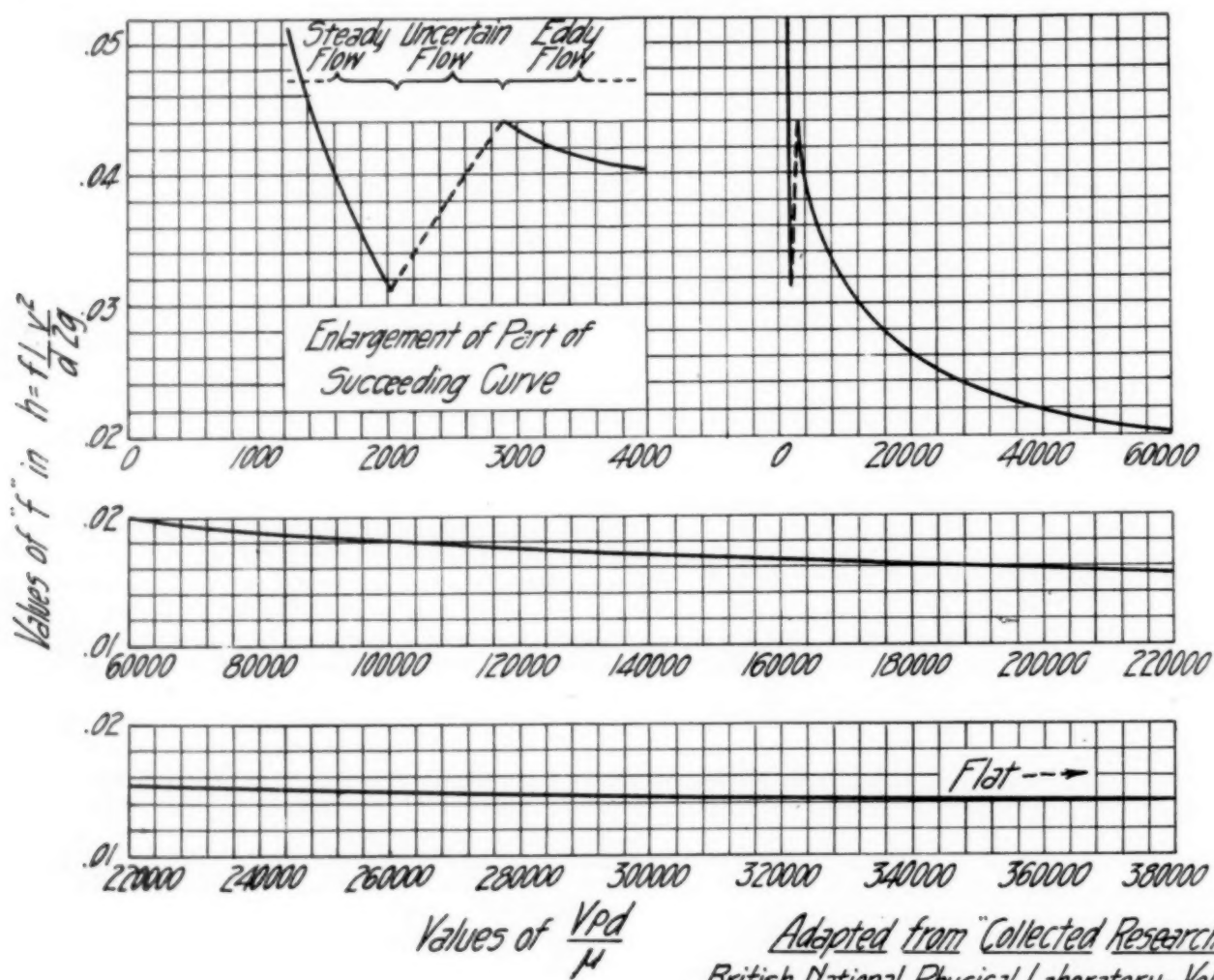
FIG. 3. RELATION BETWEEN FRICTION FACTOR AND $vd/\mu\rho$.

factorily demonstrated. From this fact it follows that if a series of experiments were conducted on the flow of liquids of conveniently varying Saybolt viscosities, the results would serve once and for all as a basis on which to calculate the friction losses of other liquids within the same Saybolt range. But with the aid of the Bureau of Standards calibration it becomes unnecessary actually to carry out such a set of experiments; for we may determine the kinematic viscosity, $\frac{\mu}{\rho}$, directly from the instrument and Fig. 2, and then

$\frac{v\rho d}{\mu} = 2{,}050$, while uncertain flow changes again to the regular condition of eddy flow at the post-criterion, $\frac{v\rho d}{\mu} = 2{,}900$.

The appearance of the first two branches of the curve in Fig. 3 is so irregular as to require some explanation. In the experiments at the National Physical Laboratory, from which the curve was plotted, the method used was to observe all the quantities in equa-

tion (7), and solve for *f*. This was rational as long as the character of flow was of the regular eddy type, to which alone the equation applies. But the experimenters used the same process when the flow was steady and also when it was in the uncertain régime; so that they were then arbitrarily forcing their experimental values into an equation which does not properly present the facts. In this way they got the values of *f* shown in the first two branches of Fig. 3, which serve a legitimate purpose in illustrating the fundamental truth that friction loss depends on velocity, diameter and kinematic viscosity, but give an erroneous idea of the true relations of these factors. The same truth is expressed, with reference to the régime of steady flow, by equation (1), which shows equally well that friction loss depends on the factors mentioned, and shows the real nature of the relation; and as a matter of fact, if values of *h* be computed from equation (1) and then substituted in equation (7) to deduce values of *f*, these latter will lie exactly on the first branch of the curve in Fig. 3.

Equation (7) itself, although it is perhaps the most generally accepted statement of the law of hydraulic (eddy) flow, is quite likely to mislead the student unless he notes carefully the significance of the coefficient *f*. This coefficient is not constant, but varies with every variation of *v* or *d*. For use with formula (7) it is necessary to provide an extensive table of values of *f*, showing its changing value over the desired range of velocity and diameter. The general form of the equation gives the impression that friction loss varies as the square of the velocity, but that is not really the case; the variable coefficient *f* acts to reduce the computed value of *h* to what it would have been if the exponent of *v* had been written correctly, its true value being 1.74 for the drawn pipes under consideration, and about 1.80 for wrought and cast iron pipes of ordinary roughness. In the present case, for a constant kinematic viscosity, equation (7) could be written

$$h = F \frac{l v^{1.74}}{d} \qquad (8)$$

in which *F* varies only with the diameter; or, the formula may be made general by expressing *F* as a function of *d*. This is the form which most recent experimenters have used for expressing their results. A formula established at the University of Texas for the flow of water at 68 deg. F. in clean iron pipes up to 3 in. diameter, with velocities up to 3 ft. per sec., was

$$h = 0.00685 \frac{v^{1.77}}{d^{1.27\frac{1}{2}}} \qquad (9)$$

where *h* = friction head in feet per foot and *d* = diameter in inches.

This formula has been used in connection with the present work for comparison of the results obtained by its use with those obtained from Fig. 3 and equation (7) for the case of water in drawn pipe, as an indication of the amount by which friction loss in wrought-iron pipe exceeds that in drawn pipe.

Equation (9) holds only for the limited range wherein the exponent of *v* remains constant; this exponent increases noticeably with great increase of velocity, but it remains sensibly constant throughout the working range of practical interest, so that the index relation, while not a complete statement of hydraulic law, serves as a satisfactory working rule.

(Part II will be published in a subsequent issue.)

Report on the Leather Section, Sixtieth Meeting, A.C.S.

IN THE absence of Dr. Marbaker the meeting was presided over by Dr. A. W. THOMAS, of Columbia University.

NATURE OF THE HIDE-TANNIN COMPOUND AND ITS BEARING UPON TANNIN ANALYSIS

This paper, by Dr. JOHN ARTHUR WILSON, disproves the contentions of the opponents of the new method of tannin analysis as outlined by Dr. Wilson before the American Leather Chemists Association in Atlantic City. In this previous paper comparative tests showed the official method of the American Leather Chemists Association to be greatly in error, exceeding 200 per cent for typical samples of gambier extract. The much higher percentages of tannin obtained by the A.L.C.A. method for every material examined were attributed to the formation of a readily hydrolyzable compound between the hide powder and a variable fraction of the non-tannins. The chief aim of the opposition in the A.L.C.A. was apparently to show that the low results obtained by the new methods were due to losses of tannin in the manipulation of the methods, but no readily conclusive evidence was offered in support of these contentions. The object of the present work was to investigate these points because they are of great importance not only to this new method but to the theory and practice of tanning itself.

Typical commercial tanning extracts have been chosen for examination ranging in properties from the extremes of gambier and sumac to those of hemlock and quebracho. Two mixtures have also been included, each consisting of a pair of extracts of very different nature.

Extract manufacturers often remove only about 80 per cent of the tannin from the raw materials because in order to get the last 20 per cent they have to extract a large proportion of undesirable non-tannins that would considerably lower the purity of their product. The raw materials used were extracted completely and therefore contain a higher ratio of non-tannin to tannin than the commercial extract, and this, as shown, would increase the error obtained by the American Leather Chemists Association extract.

The results of these experiments show conclusively that prolonged washing is quite without influence upon the values obtained for the per cent of tannin in various materials by the new methods; and, further, that tannin once combined with hide cannot be washed out by any amount of washing that would be practical. Thus the major contention of opponents of the new method is disproved.

It was further found that the non-tannins are capable of undergoing chemical change with the formation of substances capable of tanning. Just what chemical actions are involved in the conversion of non-tannins to tannins must remain a matter of speculation until more data are available. Oxidation, condensation and polymerization may all be involved. It is conceivable that gallic acid might be converted into digallic acid under suitable conditions, and it seems extremely likely that a polymerized form of digallic acid would have tanning properties. A detannized solution which gives no test for tannins can

be made to give a strong test merely by passing oxygen gas through it. Long exposure to air has a similar action. It is evident that the new method furnishes a valuable means of studying the conversion of non-tannins into tannins and might conceivably be applied to a study of the formation of tannins in nature and to the aging of barks.

Experiments were further carried on to show the effect of the time factor in tanning and the aging of leather.

We feel justified in recommending that the new method, or some modification of it, be adopted as a standard to replace the present official method. One modification of the new method for routine control work is to tan the hide powder as usual, transfer it to an alundum thimble, wash it by means of a mechanical arrangement and then dry and weigh it, the increase in weight of the dry hide powder being taken as tannin. No doubt other modifications will suggest themselves as the work proceeds, but the saving of time in the A.L.C.A. method is not sufficient compensation for the errors involved.

Summarizing, tannin once combined with hide cannot be removed to an appreciable extent by any amount of washing that would be practical. It has been discovered that chemical changes are produced in the tan liquor by boiling and evaporating whereby certain non-tannins are converted into substances capable of tanning. Such changes can be followed quantitatively by means of the author's new method of tannin analysis, but not by the official method of the American Leather Chemists Association. The new method gives results which agree closely with tanning practice, whereas the A.L.C.A. method was found to be greatly in error. It is recommended that the new method be adopted as a standard.

THE MECHANISM OF BATING

Dr. JOHN ARTHUR WILSON also read a paper on "The Mechanism of Bating." The curious process of bating, so little known because of its secret origin, is at least some centuries old. After the skins are taken from the lime liquors, unhaired and washed, they are plump and rubbery, a condition not particularly suitable for putting them directly into tan liquors. The object of bating is to prepare the unhaired skins for tanning, and originally consisted in keeping them in a warm infusion of the dung of dogs or fowls until all plumpness had disappeared and the skins had become so soft as to retain the impression of thumb and finger when pinched and sufficiently porous to permit the passage of air under slight pressure. As a result of investigation the use of dung as a bating material has been replaced in many tanneries by the mixture of ammonium chloride and pancreatin.

The question arises as to whether bating is not simply a means of bringing the skins into a condition of minimum swelling, especially since such a condition would give the skins those physical properties which are widely accepted as indicative of properly bated skins. If this is so it would reduce bating to perhaps the simplest of the tannery processes.

Experiments show that a pure solution of ammonium chloride, of the same concentration and alkalinity as the bate liquor, produces practically the same degree of swelling. Another test was made by comparing the action of ammonium chloride alone with that of a commercial bate, supposedly containing ammonium

chloride and pancreatin. This test indicated either that pancreatin was of no practical benefit or else that the commercial bate was deficient in enzymes.

What Rosenthal proved was merely that bating removed almost to completion certain nitrogenous matter from the limed skin, but whether this was elastin or hide substance which had previously been attacked by lime appears open to question. Other investigators concluded that elastin is present only in the grain membrane and that it must be digested before tanning to produce a satisfactory grain, but that the bating of the skin under the grain is not only unnecessary but often undesirable.

We have made experiments to determine definitely the question of the removal of elastin in the bating process by means of photomicrographs of cross-sections of the skin taken before and after bating. Fibers were stained with magenta to make the elastin fibers discernible. Microscopic examination of a piece of skin from the trypsin liquor used showed that practically all of the elastin had been removed, while on a piece treated with ammonium chloride only the elastin was left apparently unaltered. The view of Seymour-Jones that the main body of skin contains no elastin was substantiated.

The value of removing elastin from skins must depend to some extent upon the particular properties desired in the leather. The mechanism of bating evidently consists of two distinct parts: (1) Reducing limed skin to a condition of minimum swelling and (2) digesting the elastin fibers present in the outer layer of the skin.

NITROGENEOUS FERTILIZER FROM TANNERY WASTE SULPHIDE LIQUORS

D. H. KADISH presented a paper on "A New Method for the Recovery of Nitrogenous Fertilizer Material From Tannery Waste Sulphide Liquors."

There are two methods of liming—namely, the still and paddle process and the sodium sulphide process. Both methods give about the same result in the finished leather, although the second method is not so foolproof as liming. In the first method hair is recovered, but in the second method it is dissolved. This hair is at present sold on the market for a price that makes it worth while saving, while there is a question of the disposal of liquor in the second method. At the present time this is turned into the sewer, but we believe it may be recovered economically.

The method designed for this recovery consists of a tank into which the waste sulphide liquor is poured and from which it is drawn into an orifice box and subsequently at a pipe connection meets with acids drawn from a similar tank, usually sulphuric or liquor made from niter cake. After the two have joined in the pipe the flow is carried on to a settling tank which contains a slight excess of acid. This settling tank is covered over and has an exhaust port at the top for recovering the H_2S and carrying it to a tower where it may be made into sodium sulphide and re-used. The recovery of sodium sulphide is from 50 to 75 per cent of that employed in the tanning.

At the bottom of the settling tank the liquor is finally drawn off, leaving a solid material in the tank which consists of colloids packed down of their own weight. This colloid matter, being changed to triscoids, is shoveled out like dirt. It has a maximum

water content of 10 per cent and may be sold on the market for fertilizer. The plant may be erected to have a capacity of from 3,000 to 30,000 gal. of waste liquor per hour.

The operation of the plant shows that 39 lb. of fertilizer may be recovered per 100 lb. of liquor. This fertilizer has an average content of 12 per cent ammonia and sells at the rate of about $72 per ton. The operation cost is slight. Analysis of the fertilizer showed 11.04 per cent nitrogen or 13.18 per cent ammonia. This plant has been erected at the Pfister & Vogel tannery at Milwaukee and the process is covered by U. S. Patents 1,269,189 and 1,298,960.

CHEMICAL CONTROL OF THE TANNERY

While the paper, "Chemical Control of the Tannery," by F. C. ORTHMANN, came from one of the finest leather laboratories in the United States, it was a mere outline of methods that might well be employed in many laboratories. It is generally a method of keeping records and abstracts for heads of departments with loose-leaf binders, including the analysis of all compounds that are purchased or sold from the tanneries.

SWELLING AND FALLING OFF OF WHITE HIDE IN VEGETABLE TAN LIQUORS

"The Swelling and Falling Off of White Hide in Vegetable Tan Liquors," by G. D. McLAUGHLIN and R. E. PORTER, was a paper in which the authors reported an exhaustive set of tests, plotting ten sets of curves showing the action of a hide with lactic, acetic, pyrogallic and gallic acids, together with the calcium compounds of same.

The result showed that vegetable tanning liquor may not be regarded as an entity and that lactic acid is a natural reagent. This latter is good to use in the tannery and the specific amount should be worked out for local conditions. Acetic acid is dangerous in too great quantities.

Excess gallic acid gives a thin, poorly tanned leather.

Lactic acid is particularly good for a mellower in a new tannery starting into operation. The methods of tests have shown that they are good for judging astringency. The samples used were taken from a uniform rectangle cut just above the tail of the hide.

In the discussion of this paper SIGMUND SAXE, of New York, stated that it was one of the best papers he had ever heard on the subject.

THE INFLUENCE OF NON-TANNIN ACIDS ON THE TANNIN CONTENT OF TAN LIQUORS

ALAN A. CLAFLIN made an exhaustive set of tests on chestnut and quebracho extracts and gave the results of his experiments in a paper entitled "The Influence of Non-Tannin Acids on the Tannin Content of Tan Liquors." He expects to continue to cover a series of other extracts. Experiments were presented on the whole series in a half-way state of the work. The author entered a plea for other chemists to also take up this work.

The experiments were based on the action of non-tannin acids—i. e., that sulphuric acid will precipitate tannin and fermentation will cause a loss of tannin. Dilute sulphuric acid causes a heavy precipitate which is not analyzed in the literature at present available. Fermentation changes tannin to gallic acid.

The theory is that tannin anhydrides are formed and analyses were made before and after the addition of the non-tannin acids to the extract solution. The A.L.C.A. method of analysis was used in the first set of experiments. The results of the work with the extracts were tabulated to show the solids and insoluble matter with no acid, with normal lactic acid, with acetic, sulphuric and hydrochloric acid.

The discussion brought out the fact that the results were not surprising, because so-called spruce or ligno-sulphonic acid from the paper mills gives a clear solution on testing.

THE EFFECT OF CONCENTRATION OF CHROME LIQUOR UPON THE ADSORPTION OF ITS CONSTITUENTS BY HIDE SUBSTANCE

ARTHUR W. THOMAS and MARGARET W. KELLY presented a paper on "The Effect of Concentration of Chrome Liquor Upon the Adsorption of Its Constituents by Hide Substance," which is a continuation of the work that Dr. Thomas is carrying on in colloids at the Research Laboratory of Pure Chemistry, Columbia University. This work is being carried out under the funds of the Gallun Co., and all results of work are to be made available to the public. This is just another example of the attitude of a generous manufacturer in making public all research carried out under funds furnished by the company. Such a spirit will go far in the development of our leather industries.

The experiments reported in this paper were conducted to test whether the adsorption from various liquors containing 0.038 to 6.640 g. of chromic oxide per 100 c.c. of liquor, insuring a maximum at concentration of 1.5 to 2.0 g. of chromic oxide per 100 c.c. would not have shown a point of minimum beyond which increasing concentration would have caused greater fixation of chrome if the liquors had been carried to higher concentration. The results of the experiments are shown in Tables I and II.

TABLE I

Number	Gms. Cr$_2$O$_3$ per 100 c.c. of Liquor Before Adsorption	Composition of Chromed Hide Powder			
		Protein per Cent	Cr$_2$O$_3$ per Cent	SO$_3$ per Cent	Ash, per Cent
1	0.0363	98.19	1.30	1.09	1.59
2	0.2881	83.70	7.86	6.07	8.84
3	0.7738	76.63	10.58	8.18	11.82
4	1.5526	75.90	10.85	8.67	12.12
5	3.0853	78.43	10.25	8.89	11.23
6	4.8073	80.17	9.36	8.25	10.09
7	7.3070	83.87	7.85	7.21	8.62
8	9.7267	84.83	5.92	6.12	6.50
9	12.175	89.77	3.86	5.19	4.89
10	14.754	90.67	2.35	4.48	3.82

TABLE II. COMPOSITION OF LIQUORS AFTER ADSORPTION

Number	Grams Cr$_2$O$_3$ in 100 c.c.
1	0.0096
2	0.0510
3	0.4464
4	1.2586
5	2.8577
6	4.7587
7	7.4350
8	10.0215
9	12.5820
10	15.4000

The values obtained show removal of hydrogen ion from the liquors up to the solution of concentration of 7.4 g. of chromic oxide per 100 c.c., beyond which the curves join and run together, indicating that if hydrogen ion was removed it was so slight that the buffer action of the chromic sulphate could take care of it.

The authors concluded that on experience to date the reaction between chromic sulphate solutions and hide substance is chemical and not physical. If the adsorption were a simple physical process—namely, merely a partition of the chromic oxide and sulphuric acid between the solid hide substance phase and the solution phase—the curve should follow Henry's law, $C_1 = kC_2^n$, which is parabolic in shape. As the experiments show, the curve begins to slope downward after the concentration of the liquor exceeds approximately 25 grams of chromic oxide per liter in the solution of the composition $Cr(OH)SO_4$.

DYES AS USED IN THE LEATHER TRADE

"Dyes as Used in the Leather Trade," by P. R. ROBERTS, was a plea that the tannery chemists test all dyestuffs before purchasing with regard to reduction of strength of the leather, retardation of penetration or action to generally deteriorate. The specific gravity of the various dyes entering into mixtures should run even because of possible segregation in the mill. Every tannery should have a dye labaratory and not use a mixture that will settle out compounds of different specific gravities. The dye chemists of the tanneries should co-operate with the color house for securing proper colors in the dyeing of leather.

DETERMINATION OF HYDROCHLORIC ACID AND NEUTRAL CHLORIDES IN LEATHER

"The Determination of Hydrochloric Acid and Neutral Chlorides in Leather" was discussed by ARTHUR W. THOMAS and ALEXANDER FRIEDEN. The extent to which sulphuric acid in leather will rot the finished product is an important one to vegetable tanners, but sulphuric acid is only one of the mineral acids that may be present, and if the work is to be complete hydrochloric acid must be included. The method of analysis depends on the principle that divalent ions are adsorbed more readily than the trivalent ions. Ammonium and sodium phosphate was used in making the test, while ethyl alcohol was used as a solvent for the chlorides.

The chlorides were precipitated with silver nitrate with a slight extract of nitric acid to wash down the organic content. The nitric acid was present in sufficient quantity to prevent the forming of silver phosphate and did not impair the accuracy of the method. It was obvious from the experiments carried out that the water extraction could not be used for separation of neutral chloride from acid chloride in leather.

Hence, in our opinion, acids are combined chemically with collagen provided they come in contact with the collagen before all the free valences of the collagen are satisfied by tanning agents and the removal of an acid from leather by hot water is due to hydrolysis. It is evident, then, that the hydrochloric acid collagen compound is hydrolyzed much more readily than the sulphuric acid collagen compounds.

The results obtained by the methods employed were compared with the amounts of chloride obtained by the method of determination by ashing the leather soaked with sodium carbonate solution and covered with dry sodium carbonate. The ashing was conducted at as low a heat as possible and the amount of chloride present in the sodium carbonate was determined and correction applied in each case.

The total chloride found by ashing at low heat in the presence of alkali is in every case higher than the total chloride found by the phosphate digestion. This is due to the chlorine present as a part of the protein molecule, or present in the leather in forms other than chloride.

An objection might be raised for the use of ethyl alcohol, which is difficult to obtain in quantity on account of restrictions imposed due to the new law. We see no reason, however, why denatured alcohol that has been twice distilled, first over phosphoric acid and then over alkali, would not serve just as well as pure ethyl alcohol.

"Comment on Wilson's and Kern's Recent Contribution to the Knowledge of Vegetable Tanning Agents" was given by A. W. THOMAS. In a recent work by Wilson and Kern, which showed large errors obtaining by use of the official method of the American Leather Chemists Association, these errors were shown as follows, in order of the greatest amount of non-tannins:

	Per Cent		Per Cent
Gambier	220	Larch bark	89
Osage orange	198	Oak bark	88
Sumac	166	Hemlock bark	63
Chestnut wood	117	Quebracho	43

Since tannins react with gelatine to form insoluble compounds while non-tans do not so react with gelatine, it was considered that a comparative measure of the content of non-tans in extracts could be indicated by their diffusion through gelatine jelly, the extent of the diffusion being measured by the formation of a black color. The results of experiments along these lines were as follows:

DIFFUSIONS OF NON-TANS THROUGH GELATINE JELLY

Material	48 Hr. Mm.	96 Hr. Mm.	144 Hr. Mm.	216 Hr. Mm.
Sumac	17.3	22.3	27.0	32.5
Gambier	13.8	18.0	22.0	26.0
Chestnut wood	12.0	17.8	20.0	23.8
Oak bark	9.0	13.0	15.2	18.3
Larch bark	9.0	12.0	14.5	16.0
Hemlock bark	6.0	8.3	9.5	12.0
Osage orange	4.3	4.8	5.0	6.0
Quebracho	3.8	4.8	5.8	7.3

The order of diffusion of the non-tans was, therefore, sumac > gambier > chestnut wood > oak bark > larch bark > hemlock bark > quebracho > osage orange.

With the exception of osage orange, the order found here is similar to the order given by Wilson and Kern. This is, therefore, confirmatory of the work which has been previously mentioned.

BUSINESS MEETING

At the close of the technical papers, the Section held its annual business meeting, and elected Dr. John Arthur Wilson as Chairman and G. D. McLaughlin as Secretary of the Section. It was further voted that the Leather Section will not meet at the spring meeting of the Society in Rochester, but will hold one large meeting in New York next September.

Colored Plasters

The investigation of colored plasters by the Bureau of Standards has been completed. It has been found possible to make colored wall plasters of any desired color or texture by use of dyed wood fiber in gypsum plaster. Panels of this material have been submitted to the Gypsum Industries Association in Chicago, and a publication on the subject is now being prepared.

Manufacture of Rich Copper: Aluminum Alloys or Hardeners

Describing the Methods in Use in Aluminum Foundries of the United States for Manufacturing Rich Alloys of Copper and Aluminum, and Details of Experiments Carried Out for the Purpose of Comparing Different Methods

By ROBERT J. ANDERSON*

THE use of rich copper: aluminum alloys for introducing copper into aluminum in the manufacture of No. 12 alloy or similar other light aluminum: copper alloys is an old practice, and it dates back to the early days of aluminum founding. As has been pointed out[1] by the present writer, copper may be alloyed with aluminum in making up alloys for sand casting by two distinct methods; (1) by adding solid copper to liquid aluminum, and (2) by charging a rich copper: aluminum alloy with the aluminum. The majority of the aluminum foundries in the United States prefer to make up heats of No. 12 alloy by using a rich alloy containing about 50.0 per cent copper and 50.0 per cent aluminum. This rich alloy is referred to in foundry parlance as "hardener," "rich alloy" or "50:50," and for brevity it will be referred to in this paper as 50:50 alloy. Another alloy preferred by a few is the eutectic containing 33.0 per cent copper and 67.0 per cent aluminum. A rich alloy containing 60.0 per cent copper and 40.0 per cent aluminum has also been suggested for the same purpose, but it has probably not been used commercially.

In the metallurgy of aluminum alloys, rich alloys are employed because they melt at temperatures lower than aluminum and, further, because they are brittle. The latter property permits them to be broken readily into small pieces, and thus to be weighed accurately. Originally, the rich alloys were used because they were a convenience, but under the conditions of fast practice in the large aluminum foundries of the United States, their use has become a necessity. Methods for preparing the rich copper: aluminum alloys vary somewhat in different foundries, but experience indicates that certain details in manufacture must be followed closely in order to avoid heavy dross losses. Whether the 33:67 or the 50:50 alloy is made is not a matter of a great deal of importance from the metallurgical standpoint, since the fundamental principles involved are the same for either alloy.

METHODS USED COMMERCIALLY

There are three distinct methods in use for the manufacture of rich copper: aluminum alloys (50:50), of which the second is the most generally used; the two other methods are employed mainly in small foundries for making small lots of hardener for their own consumption. These methods are essentially carried out as follows: (1) By adding solid aluminum to liquid copper; (2) by adding liquid copper to liquid aluminum; and (3) by adding solid copper to liquid aluminum. The alloys may also be prepared by pouring liquid aluminum into liquid copper, but the opportunity for segregation is greatly increased in this way, and this is, in fact, a decidedly inadvisable method.

SOLID ALUMINUM TO LIQUID COPPER

Rich alloys, such as 50:50 alloy, are made in a few foundries by the addition of solid aluminum to liquid copper; this is, however, not a desirable procedure. One way of carrying out this method in the foundry is to melt the copper in a crucible and then add small amounts of cold aluminum from time to time with stirring until the requisite amount of aluminum has been put in. Too much aluminum cannot be added at one time, unless the copper is greatly superheated, or the entire melt will freeze. Ordinarily, it is necessary to maintain the temperature of the copper in the crucible by holding the pot in the furnace with the burners on. This is wasteful of fuel, and the method is slow and conducive to heavy dross losses. It is still used, however, in some small foundries in spite of its very obvious disadvantages.

LIQUID COPPER TO LIQUID ALUMINUM

The most favored method for making rich alloys consists in melting the copper and aluminum separately and then pouring the liquid copper into the liquid aluminum. The resultant alloy is vigorously stirred to insure thorough alloying and prevent segregation; the alloy is then ingoted in the form of pigs of various convenient sizes from 10 to 60 lb. or more. Where large lots are made at one time, it is good practice after melting the metals to pour the liquid aluminum into a large mixing vessel or container and then pour the copper into the aluminum. For convenience, the mixing vessel should be located near the furnace used for melting the copper.

As it is important to keep the temperature of the resultant alloy as low as possible so as to avoid heavy dross losses, the liquid aluminum should be chilled by adding cold aluminum ingot or notch bar. Thus only part of the aluminum to be used should be melted—say about two-thirds—and the remainder should be retained for use in lowering the temperature of the alloy during the time the copper is being put in and afterward.

It requires considerable skill to maintain the resultant alloy at a low temperature because of the considerable rise in temperature which takes place when liquid copper is added to liquid aluminum.[2] The temperature rise is conducive to heavy dross losses, and it is best counteracted by the addition of sufficient cold aluminum in amount depending upon the temperatures of the liquid aluminum and liquid copper. Experience, together

with pyrometric measurements of the temperatures, will best indicate the correct procedure.

SOLID COPPER TO LIQUID ALUMINUM

This method for preparing rich alloys is similar to the method used for preparing No. 12 alloy by direct additions of solid copper to liquid aluminum. It is not used to any extent because foundries which prefer to add solid copper to liquid aluminum in the manufacture of No. 12 alloy do not use rich alloys. However, a few instances of the commercial use of this method have been reported. The method is carried out simply by melting the aluminum and then adding small amounts of light copper (sheet, punchings or other scrap) from time to time until the required amount of copper has been put in. After each addition of copper, the melt is stirred until the copper goes into solution. Dross losses are normally high in this method; furthermore, it is slow and not suitable for making large lots of 50:50 alloy.

LIQUID ALUMINUM TO LIQUID COPPER

No instances of pouring liquid aluminum into liquid copper as a commercial practice for the manufacture of 50:50 alloy have been reported, although this has been tried. A modification of this method is used, however, in some small foundries for making up small lots. In this modification, the copper is melted in a crucible, preferably in a stationary gas- or oil-fired furnace. A small notch bar of aluminum is held by tongs in the mouth of the furnace so that it gradually melts; as it melts, drops of liquid aluminum fall into the liquid copper. The resultant alloy is stirred from time to time until all the aluminum has been put in. This is a slow and expensive method, and conducive to high oxidation losses.

COMPARISON OF THE METHODS

In the commercial manufacture of rich alloys of copper and aluminum, the consensus of opinion among the larger foundries is that liquid copper should be poured into liquid aluminum, with an endeavor at the same time to keep the temperature low by chilling the melt with additions of cold aluminum ingot; this should be accompanied by vigorous stirring. Where solid aluminum is added to liquid copper, there is danger of explosions from absorbed water in the aluminum, and in this method the aluminum should be preheated so as to drive out any water. This can be done by placing the notch bars on top of the furnace while the copper is melting. This method is conducive to heavy dross losses because of the high temperatures and the thermit reaction if much copper oxide is present (as there usually will be unless the copper is melted under charcoal). This method is also slow and wasteful of fuel; only small amounts of cold aluminum can be added at a time, otherwise the whole melt will freeze. In general, this method is undesirable and but little used.

When liquid copper is poured into liquid aluminum, the temperature of the resultant alloy may become high because of the normal heat of formation of the alloy, and further, because of the thermit reaction which usually takes place. This is the only serious disadvantage in thus making the rich alloys, but it may be largely minimized by keeping the temperatures low by adding cold aluminum. This method is, in fact, the standard method for the manufacture of 50:50 alloy
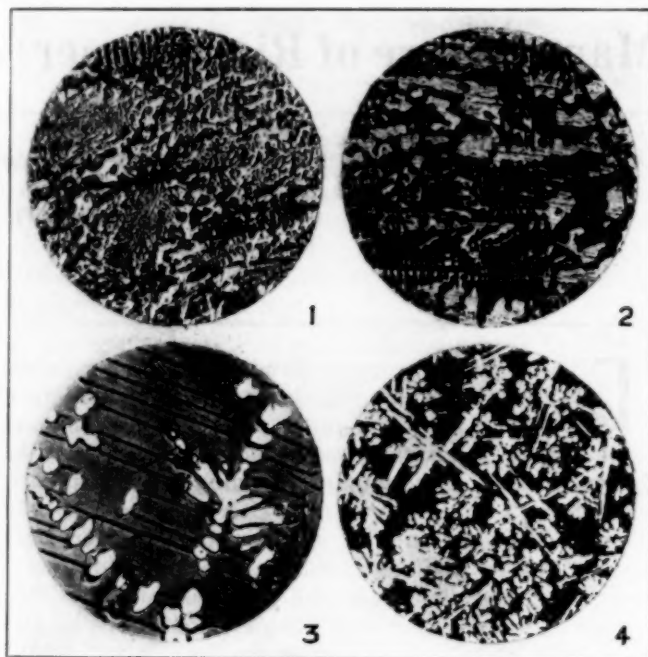
FIGS. 1 TO 4.

Fig. 1—Eutectic alloy of copper and aluminum (33Cu : 67Al); etched NaOH; × 130. Fig. 2—Eutectic alloy of copper and aluminum; etched Fe₂(SO₄)₃; × 230. Fig. 3—Rich copper : aluminum alloy (50Cu : 50Al); etched NaOH; × 130. Fig. 4—Rich copper : aluminum alloy (60Cu : 40Al); etched NaOH; × 35.

on a large scale, and while it is suitable for making both large and small lots, the method of adding solid copper to liquid aluminum may be preferable for small lots, say about 100 lb. Comparative figures as to dross losses for the various methods will be given later.

PROPERTIES OF THE RICH ALLOYS

Alloys containing 33:67, 50:50, and 60:40 copper: aluminum are all white in color, similar to aluminum, but the fractures are coarsely crystalline and bright. These alloys are all brittle, but the excessive brittleness diminishes with increasing aluminum content; thus, the 33:67 alloy is not so brittle as the 50:50 alloy, but the 60:40 alloy breaks readily if dropped on the floor. The 50:50 alloy is sufficiently brittle for all practical purposes, and if the rich alloys are too brittle, they powder excessively on breaking, thus causing dusting losses. Typical microstructures of these several alloys are shown in Figs. 1 to 4. The characteristic acicular structure formed when 50:50 alloy freezes uninterruptedly is shown in Fig. 5; the large interlocking crystals are conducive to brittleness, and this characteristic, together with the actual brittleness of the compound $CuAl_2$, makes the alloy easy to break.

The eutectic alloy (33Cu : 67Al) melts at 540 deg. C., the 50:50 alloy at 575 deg. C. and the 60:40 alloy at 658 deg. C., practically the same temperature as aluminum.

EXPERIMENTS WITH RICH ALLOYS

In foundry practice, the rich alloys used for introducing copper into aluminum in the manufacture of No. 12 alloy and other such alloys include the 33:67 and 50:50 copper:aluminum alloys. The preparation of these rich alloys, as well as the 60:40 alloy, was studied in connection with the present investigation. A rich alloy containing 60.0 per cent copper and 40.0 per cent aluminum is very brittle, and it melts at about the same temperature as aluminum. In using this alloy, less of

TABLE I. SUMMARY OF THE RICH ALLOY EXPERIMENTS

Experiment	Wt. Copper, Lb.	Wt. Aluminum, Lb.	Time Required to Melt Copper, Min.*	Time Required to Melt Aluminum, Min.*	Temperature Copper, Deg. C.	Temperature Aluminum, Deg. C.	Highest Observed Temperature of Alloy, Deg. C. †	Final Temperature of Alloy, Deg. C.	Alloy Poured at, Deg. C.	Wt. Pigs Poured, Lb.	Wt. Dross Recovered, Lb.	Shrinkage, Lb.	Total Loss, per Cent	Metal Oxidized, per Cent ‡	Total Gas Consumption, Cu.Ft. §	Cost Gas Used, Dollars ¶	Alloy Made
A-1	8.25	16.75	26.0	....	1,155	25	....	705	700	24.00	0.85	0.15	4.0	1.80	3,860	1.16	33:67
A-2	8.25	16.75	28.0	27.0	1,125	880	1,065	1,065	1,040	24.15	0.65	0.20	3.4	1.38	5,915	1.77	33:67
A-3	8.25	16.75	....	26.0	820	25	925	890	874	23.55	1.15	0.30	5.8	2.44	2,730	0.82	33:67
B-1	12.50	12.50	38.0	....	1,120	25	1,225	685	677	23.75	1.00	0.25	5.0	2.12	4,730	1.42	50:50
B-2	12.50	12.50	40.0	26.0	1,203	705	1,085	1,080	1,061	23.50	1.00	0.50	6.0	2.12	7,130	2.14	50:50
B-3	12.50	12.50	....	24.0	25	690	906	900	887	22.25	2.25	0.50	11.0	4.77	3,145	0.94	50:50
C-1	15.00	10.00	42.0	....	1,170	25	1,278	860	842	22.60	2.00	0.40	9.6	4.24	4,620	1.39	60:40
C-2	15.00	10.00	43.0	21.0	1,205	750	1,256	1,225	1,190	23.50	1.00	0.50	6.0	2.12	6,935	2.08	60:40
C-3	15.00	10.00	....	22.0	25	783	855	809	787	22.15	2.55	0.30	11.4	5.41	3,360	1.01	60:40

* Solid metal temperatures are taken as room temperature—i. e., 25 deg. C.
† The figures indicate the observed highest temperatures; higher temperatures may have been attained, but they were not observed.
‡ Based on the assumption that dross is equivalent to Al_2O_3, containing about 53.0 per cent aluminum.
§ The copper-melting furnace consumed 110.0 cu.ft. per min., and the aluminum-melting furnace 105.0 cu.ft. per min.; in some cases additional gas was used in addition to that reqiured for melting.
¶ Based on gas at $0.30 per 1,000 cu.ft.

it is required to make up a heat of No. 12 alloy than when using either of the two other rich alloys. For these reasons, the preparation of the 60:40 alloy was also investigated.

The metals were melted in gas-fired crucible furnaces, using natural gas as the fuel and plumbago-clay crucibles. The resultant liquid alloys were stirred with an iron rod from which any oxide was carefully scraped after using. The alloys were poured into small pigs weighing from 4 to 6 lb. each. Higher temperatures were taken with a platinum thermocouple protected by a quartz tube; and the lower temperatures were taken with a Wilson-Maeulen "pyod," using an indicating portable meter. The materials employed consisted of heavy copper clippings, light copper punchings and aluminum ingot of the analysis given in the subjoined table:

Material	Cu	Elements, per cent Fe	Si	Al*
Aluminum ingot	0.25	0.39	0.31	99.05
Light copper punchings	99.89	....	....	....
Heavy copper clippings	99.92	....	....	....

* Aluminum, by difference.

The heavy copper used in experiments A-1, A-2, B-1, B-2, C-1 and C-2 was in the form of heavy clippings about ½ to 1 in. thick. The light copper used in experiments A-3, B-3 and C-3 was in the form of light punchings and clippings about 16 to 18 gage. The cold materials were charged into hot crucibles at a mean temperature of 600 deg. C., but this is an approximate mean temperature, as the variations were from 400 to 700 deg. C.

It required, on the average, 27 min. to heat a cold crucible to 600 deg. C., or a metered gas consumption of 2,800 to 2,900 cu.ft. The experiments are described in considerable detail below and are summarized in Table I.

33:67 COPPER:ALUMINUM ALLOY

This alloy was prepared by the three different methods mentioned above.

Experiment A-1. In this experiment, solid aluminum was added to liquid copper so as to make the desired alloy.

|	
Charged copper into a hot crucible at 600 deg. C., lb.	8.25
Time required to melt copper, min	26.0
Gas consumption, cu.ft.	2,860
Temperature of the copper at the time the first aluminum addition was made, deg. C.	1,155
Charged aluminum in small amounts every few minutes during 30 minutes, lb.	16.75
Final temperature of the alloy, deg. C.	705
Total gas consumption, cu.ft.	3,860
Poured into pigs at, deg. C.	700
Weight of pigs poured, lb.	24.0
Weight of dross recovered, lb.	0.85
Shrinkage, lb.	0.15
Loss of metal due to oxidation and shrinkage, per cent	4.0
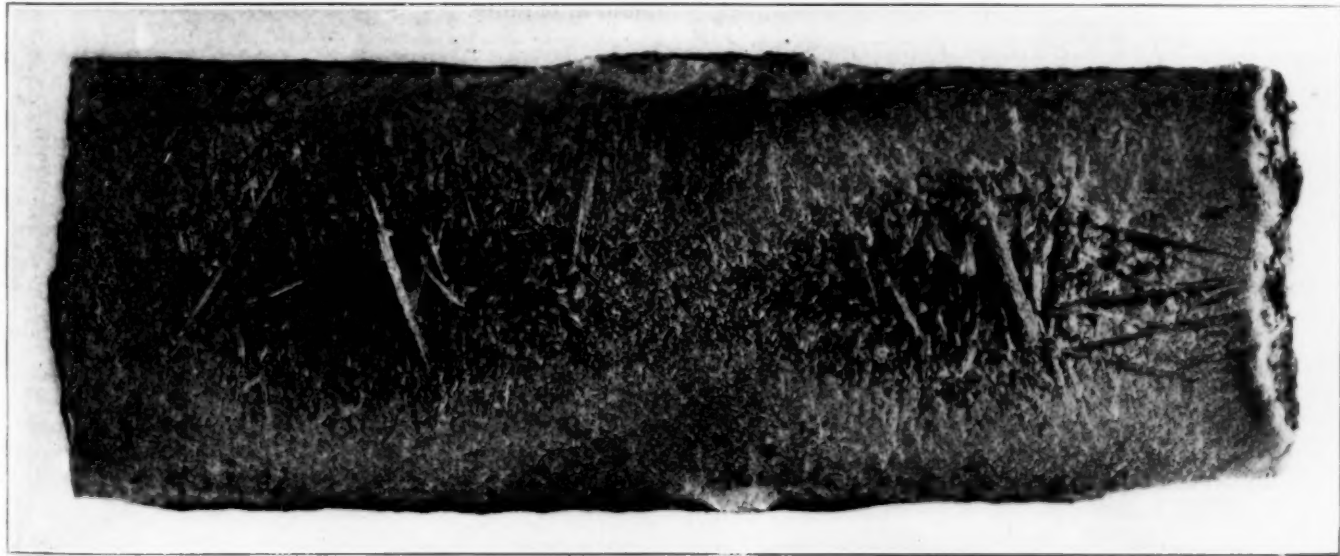
FIG. 5. UPPER SURFACE OF A CHILL-CAST PIG OF 50:50 ALLOY; × ½.

TABLE II. CHEMICAL ANALYSES OF THE RICH ALLOYS PREPARED

Alloy Made in Experiments	Elements, per Cent				Composition Aimed at
	Cu	Fe	Si	Al*	
A-1	33.85	0.54	0.41	65.20	
A-2	32.53	0.51	0.34	66.62	33:67
A-3	32.78	0.44	0.32	66.46	
B-1	49.27	0.43	0.34	49.96	
B-2	48.73	0.49	0.35	50.43	50:50
B-3	49.73	0.55	0.35	49.37	
C-1	60.25	0.46	0.31	38.92	
C-2	59.57	0.58	0.35	39.52	60:40
C-3	58.04	0.55	0.39	41.02	

* Aluminum by difference.

Experiment A-2. In this case, liquid copper was poured into liquid aluminum.

Charged copper into a hot crucible at 600 deg. C., lb.	8.25
Time required to melt the copper, min.	28.0
Gas consumption, cu.ft.	3,080
Temperature of the copper at the time it was poured into the liquid aluminum, deg. C.	1,125
Charged aluminum (in a separate crucible) at 600 deg. C., lb.	16.75
Time required to melt the aluminum, min.	27.0
Gas consumption, cu.ft.	2,835
Temperature of the aluminum at the time the copper was poured in, deg. C.	880
Highest temperature of the resultant alloy, deg. C.	1,065
Total gas consumption, cu.ft.	5,915
Poured into pigs at, deg. C.	1,040
Weight of pigs poured, lb.	24.15
Weight of dross recovered, lb.	0.65
Shrinkage, lb.	0.20
Loss of metal due to oxidation and shrinkage, per cent	3.4

Experiment A-3. Solid copper was added to liquid aluminum in this experiment in order to produce the desired alloy.

Charged aluminum into a hot crucible at 600 deg. C., lb.	16.75
Time required to melt the aluminum, min.	26.0
Gas consumption, cu.ft.	2,730
Temperature of the aluminum at the time the first addition of copper was made, deg. C.	820
Charged copper in small amounts every few minutes during 20 minutes, lb.	8.25
Highest temperature of the alloy, deg. C.	925
Total gas consumption, cu.ft.	2,730
Poured into pigs at, deg. C.	874
Weight of pigs poured, lb.	23.55
Weight of dross recovered, lb.	1.15
Shrinkage, lb.	0.30
Loss due to oxidation and shrinkage, per cent	5.8

50 : 50 COPPER : ALUMINUM ALLOY

This alloy was made under the same conditions and by the different methods described above for the 33 : 67 alloy—i.e., by adding solid aluminum to liquid copper, by adding liquid copper to liquid aluminum and by adding solid copper to liquid aluminum.

Experiment B-1. In this experiment solid aluminum was added to liquid copper so as to make the desired alloy.

Charged copper into a hot crucible at 600 deg. C., lb.	12.50
Time required to melt the copper, min.	38.0
Gas consumption, cu.ft.	4,180
Temperature of the copper at the time the first aluminum addition was made, deg. C.	1,120
Charged aluminum every few minutes during 20 minutes, lb.	12.5
Temperature of the alloy after an addition of 2.0 pounds solid aluminum, deg. C.	1,225
Temperature rise, deg. C.	105
Final temperature of the alloy, deg. C.	685
Total gas consumption, cu.ft.	4,730
Poured into pigs at, deg. C.	677
Weight of pigs poured, lb.	23.75
Weight of dross recovered, lb.	1.00
Shrinkage, lb.	0.25
Loss due to oxidation and shrinkage, per cent	5.0

Experiment B-2. Here, liquid copper was poured into liquid aluminum.

Charged copper into a hot crucible at 600 deg. C., lb.	12.5
Time required to melt the copper, min.	40.0
Gas consumption, cu.ft.	4,400
Temperature of the copper at the time it was poured into the aluminum, deg. C.	1,203
Charged aluminum into a hot crucible at 600 deg. C., lb.	12.5
Time required to melt the aluminum, min.	26.0
Gas consumption, cu.ft.	2,730
Temperature of the aluminum at the time the copper was poured, deg. C.	705
Highest temperature of the resultant alloy, deg. C.	1,085
Total gas consumption, cu.ft.	7,130
Poured into pigs at, deg. C.	1,061
Weight of pigs poured, lb.	23.50
Weight of dross recovered, lb.	1.00
Shrinkage, lb.	0.5
Loss due to oxidation and shrinkage, per cent	6.0

Experiment B-3. Solid copper was added to liquid aluminum in this experiment.

Charged aluminum into a hot crucible at 600 deg. C., lb.	12.5
Time required to melt the aluminum, min.	24.0
Gas consumption, cu.ft.	2,520
Temperature of the aluminum at the time the first copper addition was made, deg. C.	690
Charged copper every few minutes during 20 minutes, lb.	12.5
Highest temperature of the alloy, deg. C.	906
Total gas consumption, cu.ft.	3,145
Poured into pigs at, deg. C.	887
Weight of pigs poured, lb.	22.25
Weight of dross recovered, lb.	2.25
Shrinkage, lb.	0.5
Loss due to oxidation and shrinkage, per cent	11.0

Experiment B-4. In this experiment copper was melted under a charcoal cover to prevent oxidation, and solid aluminum was then added. The temperature rise was observed.

Charged copper, lb.	10.0
Temperature of the copper at the time the aluminum was added, deg. C.	1,105
Charged solid aluminum, lb.	2.5
Temperature of the resultant alloy after the aluminum had gone into solution, deg. C.	1,220
Temperature rise, deg. C.	115

Experiment B-5. In this experiment a heat of 50 : 50 alloy was made in an electric furnace (Baily type), by adding solid aluminum to liquid copper.

Charged copper punchings into an electric furnace at 1,020 deg. C., lb.	50.0
Time required to melt the copper, min.	60.0
Power consumption, kw.-hr.	52.0
Temperature of the copper at the time the first aluminum addition was made, deg. C.	1,050
Charged solid aluminum every few minutes during 60 minutes, lb.	50.0
Final temperature of the alloy, deg. C.	965
Total power consumption, kw.-hr.	114
Poured into pigs at, deg. C.	800
Weight of pigs poured, lb.	91.5
Weight of dross recovered, lb.	14.0
Shrinkage	Gain
Loss due to oxidation and shrinkage, per cent	8.5

60 : 40 COPPER : ALUMINUM ALLOY

This alloy was made by the methods mentioned above for the 33 : 67 alloy.

Experiment C-1. In this experiment solid aluminum was added to liquid copper so as to make the desired alloy.

Charged copper into a hot crucible at 600 deg. C., lb.	15.0
Time required to melt the copper, min.	42.0
Gas consumption, cu.ft.	4,620
Temperature of the copper at the time the first aluminum addition was made, deg. C.	1,170
Charged aluminum every few minutes during 20 minutes, lb.	10.0
Temperature of the resultant alloy after adding 2.0 pounds of aluminum, deg. C.	1,278
Temperature change, deg. C.	108
Final temperature of the alloy, deg. C.	860
Total gas consumption, cu.ft.	4,620
Poured into pigs at, deg. C.	842
Weight of pigs poured, lb.	22.60
Weight of dross recovered, lb.	2.00
Shrinkage, lb.	0.40
Loss due to oxidation and shrinkage, per cent	9.6

Experiment C-2. Here, liquid copper was poured into liquid aluminum.

Charged copper into a hot crucible at 600 deg. C., lb.	15.0
Time required to melt the copper, min.	43.0
Gas consumption, cu. ft.	4,730
Temperature of the copper at the time it was poured into the aluminum, deg. C.	1,205
Charged aluminum into a hot crucible at 600 deg. C., lb.	10.0
Time required to melt the aluminum, min.	21.0
Gas consumption, cu.ft.	2,205
Temperature of the aluminum at the time the copper was poured in, deg. C.	750
Highest temperature of the resultant alloy, deg. C.	1,256
Total gas consumption, cu.ft.	6,935
Poured into pigs at, deg. C.	1,190
Weight of pigs poured, lb.	23.50
Weight of dross recovered, lb.	1.00
Shrinkage, lb.	0.50
Loss due to oxidation and shrinkage, per cent	6.0

Experiment C-3. Solid copper was added to liquid aluminum in this experiment.

Charged aluminum into a hot crucible at 600 deg. C., lb.	10.0
Time required to melt the aluminum, min.	22.0
Gas consumption, cu.ft.	2,310
Temperature of the aluminum at the time the first copper addition was made, deg. C.	783
Charged copper every few minutes during 35 minutes, lb.	15.0
Highest temperature of the resultant alloy, deg. C.	855
Final temperature of the alloy, deg. C.	809
Poured into pigs at, deg. C.	787
Weight of pigs poured, lb.	22.15
Weight of dross recovered, lb.	2.55
Shrinkage, lb.	0.30
Loss due to oxidation and shrinkage, per cent	11.4

Experiment C-4. An experiment was made in the preparation of the 60 : 40 alloy for the purpose of observing the temperature changes on adding successive amounts of cold solid copper to liquid aluminum.

Charged aluminum, lb.. 10.0
Temperature of the aluminum at the time of the first copper addition,
   deg. C.. 785

TEMPERATURE CHANGES

Additions	Temperature Deg. C.
Original melt............................	785
Added 2 lb. Cu.........................	820
Added 2 lb. Cu more....................	830
Added 2 lb. Cu more....................	850
Added 2 lb. Cu more....................	846
Added 2 lb. Cu more....................	840
Added 5 lb. Cu more....................	808

Table I gives a summary of the results of the experiments made in preparing the various rich alloys by the three different methods. Table II gives the chemical analyses of the rich alloys prepared.

DISCUSSION OF THE EXPERIMENTS

These experiments have afforded some interesting data with regard to the temperature rise noted by other observers when solid aluminum is added to liquid copper. While most of the melts were made under such conditions that copper oxide was doubtless present in the liquid copper, some showed that a temperature rise is obtained even when aluminum is added to copper melted under charcoal. Others indicated that the temperature rise observed on adding solid copper to liquid aluminum continues with successive additions. These data prove that part of the temperature rise is due to oxidation of the aluminum and part of it to the heat of formation of the alloys. Practically, therefore, it is advisable to employ oxygen-free copper for making rich alloys, and the copper should either be deoxidized before pouring into the aluminum or be melted under reducing conditions so as to prevent the presence of any considerable amount of cuprous oxide in the copper bath.

Moreover, from a practical standpoint, it is desirable to hold dross losses low in the manufacture of rich alloys as well as keep the melting costs down. By the methods employed in the present experiments, the melting costs were highest for the three alloys when the method of pouring the liquid copper into liquid aluminum was employed. This is to be expected, because two different furnaces were running in this method, one on copper and the other on aluminum. In the other methods, where one solid metal is added to another liquid metal, some saving is had by taking advantage of the residual heat in the crucibles and furnace. The total losses (made up of dross plus shrinkage) and the dross losses were lowest in the case of the method of pouring copper into liquid aluminum. These losses were very heavy in the method where solid copper was added to liquid aluminum.

In considering the dross and shrinkage losses in Table I, it should be borne in mind that the experiments were carried out on a small scale, 25-lb. charges being used. The relative order of the losses in preparing the rich alloys by the different methods is correct, but the actual figures are not representative of large-scale practice. On preparing the alloys on a large scale, the losses would be considerably lower. Moreover, it should be pointed out that ordinarily the dross is not entirely loss in commercial practice, because a considerable recovery of metal would be made by running down the dross and skimmings.

The conclusion arrived at from these experiments is that the most desirable and best way of making any of the rich alloys is to melt the aluminum and copper separately and pour the copper into the aluminum. On a large scale, where, say, 2,000 lb. of the 50 : 50 alloy is made at a time, a satisfactory procedure is to melt about one-third of the total aluminum in an iron pot or other suitable vessel; after it is melted, cold pigs from part of the remaining aluminum should be thrown in to cool the metal. Here, solid aluminum would be floating around in the liquid metal. The copper should have been previously melted separately, and with the aluminum in the above condition, about one-fourth of the copper should be poured in. The addition of the copper will raise the temperature of the aluminum, but the resultant alloy may be cooled down by throwing in more pigs of cold aluminum. Then about one-fourth or more additional copper should be added and then more cold aluminum, and so on until the two melts have been properly alloyed. The alloy should be thoroughly stirred during the additions to facilitate alloying, and should be stirred well on pouring or ladling out into pigs. These directions are admittedly only very general, and the quantities of the several additions will vary considerably with the temperatures. The manufacture of rich alloys should be carried out under the supervision of a competent melter, and the use of pyrometers for frequent temperature measurements will be of value. In any event, the effort should be made to keep the temperatures as low as is consistent with rapid alloying and not allowing the alloy to freeze in the mixing vessel.

Status of the American Potash Industry

The American potash industry is in a more promising condition than at any time since the armistice. Domestic potash production in 1920 is expected to exceed that of the banner year, 1918. The producers not only have their entire possible output under contract but are being urged to take contracts for next year.

The domestic situation has been bettered by the refusal of the German syndicate to quote prices at American ports. This throws the burden of securing bottoms, negotiating freight rates and the absorption of demurrage on the American purchaser. On the other hand, the producers have had to face labor difficulties and trouble in obtaining materials. In Nebraska, the abnormal rainfall has so diluted the brine as to make much greater amount of evaporation necessary just at the time when fuel prices are at their peak.

Large new plants are being built at Searles Lake, Marysvale, Utah, and at New Brunswick, N. J.

Searles Lake producers have reduced the borax content of their potash to 0.5 per cent. In that connection it is pointed out that the borax content of the Searles Lake potash never was so great as to be hurtful when used under normal conditions. The only places where damage resulted, it is stated, were where prolonged drought prevented the washing out of the borax. The lowering of the borax content is a very simple matter and could have been done before had it been known that it possessed an element of danger, producers state. The company which produced the potash which caused some small damage to crops is not selling its potash for fertilizer purposes this year, its entire output having been purchased by chemical users.
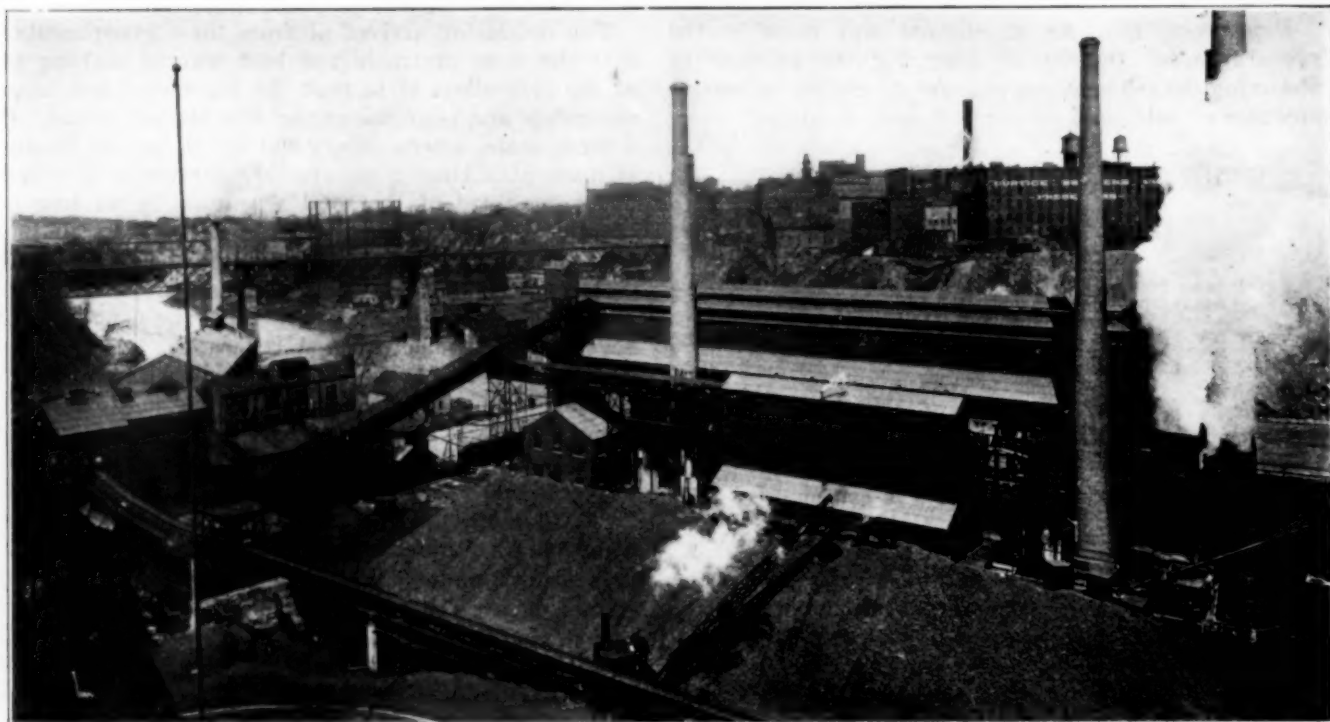
ROCHESTER COAL GAS PLANT

The Gas Industry; a Diagnosis and Prescription

The Manufacture of Gas, Although Fundamentally a Chemical Problem, Has Been, and to Some Extent Still Is, Directed on Mechanical Technologic Lines; Healthy Progress in This Industry Requires a Better Knowledge of the Chemical Fundamentals Involved

By R. S. McBRIDE*

THE title of this article implies that the gas industry is ill, and, frankly, it appears so to be. However, this conclusion need not be regarded in a pessimistic spirit, for a recognition of illness is perhaps the best promise of an early cure.

It is no simple disease from which the industry is suffering. A full diagnosis shows both mental and physiological problems. A nervous state of mind which threatens a most distressing case of melancholia is obvious to the casual practitioner who may be called into consultation. However, the root of the trouble is more serious. Careful analysis of all symptoms indicates that the patient is suffering from the gout, which has developed to its most acute and distressing stages despite the fact that the industry is simultaneously suffering from what appears to be an almost incompatible ailment—malnutrition.

A richness of opportunity has led the industry to pass through a period of opulence, during which, without proper self-restraint, it acquired all of the gouty characteristics of the dyspeptic plutocrat. At the same time neglect of important elements that must nourish the industry for any permanent healthy existence gave it the second ailment—malnutrition.

Let us lay aside this analogy and go straight to the root of the matter in plain English. The industry lacks

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today a proper vision; it stands of all great chemical industries the most negligent of science and technology except within the very narrow field of mechanical engineering; and it is almost without effective organization in the possibilities for development in lines of future need. It would be desirable to discuss the lack of science alone if this were possible, but the three points of need just cited are so interwoven that it seems impracticable to go into one without discussing all.

THE FUNCTION OF GAS

Except with respect to the ease of storage, gas certainly can be conceded to be the ideal fuel. It is clean and convenient of use and can be most efficiently applied of any heating medium. To a limited extent the industries recognize this, but the public in general, including the vast majority of technologists, has not been educated to an appreciation of this point.

The gas business not only has for its responsibility the supply of such ideal fuel but it has also the duty of furnishing a group of fundamental raw materials for other industrial chemical activities. It takes coal, the lowest form of energy supply, available through almost all parts of this country at the lowest price of any important raw material, and converts it into (1) coke, which is a fundamental metallurgical raw material, an almost ideal substitute for anthracite and an important means for other gas-making and industrial-

heating operations; (2) gas, which is the ideal fuel just mentioned; (3) tar, a liquid fuel of wonderful possibilities in the Diesel engine, a raw material for more organic industrial products than any other of which we know and a source of manifold possibilities in road making, roofing, building-paper manufacture and in other activities; (4) ammonia, which is produced as liquor, anhydrous ammonia or sulphate, as the cheapest inorganic nitrogen resource available on American markets, affording a large portion of the supply needed in explosives, fertilizer and other industries; and (5) light oils, a group of liquids whose possibilities are yet little appreciated for automotive fuel, explosives production, solvents and organic chemical production.

It is a rather appalling task which confronts the industry when the ramifications of its products are thus appreciated. The importance of proper vision and intensive scientific application should at once be apparent.

The gas business, born a century or more ago during that epoch when the rule-of-thumb system of operation prevailed, has collectively been ancestor worshipping in the most impressive Oriental style. However, since industries have ceased to pass from father to son like real and personal property, we have come into the new era of industrial life, and those industrial activities which have been born in the latter period are independent in thought, vigorous in personality and wholly unwilling to give even that respect to father and mother which enjoys Biblical admonition. Witness the automobile, the telephone, the airplane and similar recent developments. Certainly no tradition has hindered here. Gas, however, has been the anthithesis of these.

The reason for this limitation of the gas business has apparently been the character of the men consistently chosen to direct the thought of the industry. The coking of coal, the gasification of oil and the production and handling of byproducts is fundamentally a chemical problem. Unfortunately, however, it has been almost exclusively directed by the mechanical engineer without the co-operation of chemical experts. The industry has, therefore, become almost a pseudomorph of mechanical engineering. The crystal habit of mechanical technology has prevailed almost to the exclusion of chemical thought. The machinery of the industry has been excellent, but the processes and the products have not developed correspondingly. The situation now demands an opportunity for free development of the natural habit of this chemical business. We would then see those crystal forms which are the natural product of chemical and physical science quickly taking shape, and a more perfect result would inevitably follow.

PUBLIC UTILITY OR MANUFACTURING BUSINESS

Not all of the criticism offered of the present state of affairs in the gas business would be fair or reasonable if it were not clearly recognized in its presentation that some of these conditions are the inevitable result of operation of the business as a public utility. Gas manufacture has been restricted by regulations more stringent than control in any other chemical activity. Investment has been safeguarded by artificial means, but no opportunity has been given for the encouragement of epoch-making advancement in the business. Limited returns upon investment have made inevitable a certain measure of conservatism which never would have followed had it been an unrestricted manufacturing industry. Despite these obstacles, however, cer-

tain important developments can and should be achieved. Operating as a public utility rather than as an essentially manufacturing concern, the gas works manager has usually had to think of reduced cost per thousand feet of gas rather than of his major technical problems. R. B. Brown, of Milwaukee, in commenting on this particular point, brings out strikingly one of the most important reasons why the science of gas manufacture has been thus neglected.

The possible savings in the cost of gas manufacture may usually be enumerated in fractions of cents per thousand. The possible savings in the fixed charges on investment through more intensive sales policies and the increase in the units of gas sold per capita and per dollar of investment have been so tremendously greater that the most progressive and most successful operators have been those that have devoted a great deal of their attention toward increasing the volume of sales. It is a far cry from the first days when 3,000 ft. per capita was considered a good year's business and when 150 to 170 maximum days was a reasonable load factor, to present-day conditions where 10,000 ft. per capita is only a stepping stone to greater things, and 280 to 300 maximum days is considered a fair load factor.

The corresponding reductions in the cost of capital charges—interest and depreciation and taxes—per unit of gas sold have been tremendous and we are not through with that phase of the situation yet, though of course the present low purchasing power of the dollar and the present high costs of interest and of taxes have blinded many people to the fact that the greatest possible reduction in cost of operation still remain on that side of the job. Personally I am not at all blind to the possibilities in improvement of gas production processes, but financially these are not so attractive today as are many possibilities in other phases of the operation.

A whole article might be written on the subject of whether the gas-producing part of the city gas business should not be removed from the public utility field and be given free rein as a manufacturing business. However, that for the present would be altogether too great a diversion from our major theme.

VARIETY IN PROCESSES IMPORTANT

Each type of bituminous coal has its own important characteristics with respect to coking. This fact is well known and is admitted by the gas man when he is pressed for comment on this particular point. However, the significance of the point has been concealed by the gas and coking interests in saying that certain coals are good coking coals, others are poor coking coals and some are non-coking coals. As a result, in the war period, when the promoters of a certain coking process came to Washington and set forth the claim that their process could "coke any coal" they stirred official Washington tremendously. In fact they created so great a stir, despite the fact their process had no fundamental novelty to offer, that the President himself was led to take personal cognizance and order an investigation of the processes described.

The recognition of limitations of coking of each type of fuel is not enough. We should take the other point of view and study and emphasize the advantages or possibilities of each particular supply. A high-nitrogen coal is to be avoided on the score that the nitrogen content of the gas is likely to be high and, therefore, the gas is lean and may not meet certain standards of quality which have been fixed. However, if we stop to consider the possibilities of such fuel for the greater production of ammonia when rightly coked we see that this characteristic may become a blessing and not a curse of the fuel. Similarly, if we are seeking solely a
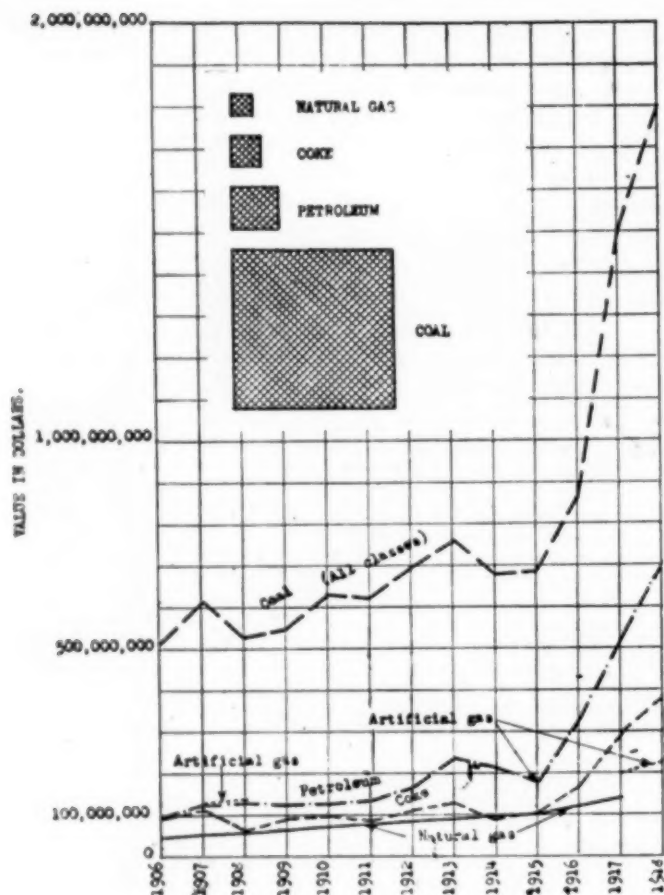
MINERAL FUELS PRODUCTION IN U. S.

This diagram, prepared by E. G. Sievers of the U. S. Geological Survey, shows the values of mineral fuels produced in this country from 1906 to 1918, inclusive. The insert rectangles show the relative total value of these fuels for the 13-yr. period.

hard, dense coke and wish a high coke yield we would not choose a typical high-volatile Pittsburgh coal to use alone. On the other hand, when we consider the possibilities of this high-volatile fuel in the greater production of gas, the much higher yield of light oils and tar, the increased possibilities in other directions thus may far outweigh the limitations and characteristics of the coke. In other words, we emphasize the possibilities and not the handicaps of our raw material.

Today practically all the gas made in this country from solid fuel is produced in the "D" retort, the Lowe-type water-gas machine, or the chamber coke oven of Koppers or Solvay type. Why we are so limited in processes is an economic question of importance. There is no doubt that these particular processes have fundamental advantages of great importance. If it were not so they could not possibly have endured so long and have been applied so extensively. However, the future must give us better opportunity than this. Low-temperature carbonization in metal retorts, the use of vacuum retorts, continuous operation, vertical retorts, steaming of coke in retorts, fractional condensation of liquid products of distillation and numerous other such possibilities are receiving some of the attention which they deserve. Out of all these we will doubtless develop a much greater variety of processes permitting the application of many fuels not now well suited to gas manufacture, because the thermal history to which these processes limit us is not suited to the characteristic of the coal.

KNOWLEDGE OF FUNDAMENTALS REQUIRED

The thermal history of the gas is important. The gas man says that the richest gas comes out of the coal first and that the lean gas remains in the coke until the end of the period of coking. This is another case of misleading use of terms which has probably been responsible for much of the misdirected effort in the coking of coals. In destructive distillation, as in any simple distillation process at lower boiling points, lighter fractions come off first and the heavier fractions remain behind until the later stages of the process. However, in destructive distillation of solid materials the quantity of the lighter materials which comes off in the early stages is so great that these materials flow rapidly out of the heated zone and many of the primary products of gasification leave the retort without being subjected to thermal disintegration. As the coking progresses the temperature increases, the quantity of material driven off per unit of time decreases and, therefore, the time and temperature of exposure of the initial products of the distillation are greater. We thus have at the later stages of heating the products of secondary decomposition of the primary products of distillation.

No one knows exactly what is the thermal history of the gases in most of the coking processes. We have still less idea as to what are the temperature ranges of formation and decomposition of each of the gas and vapor
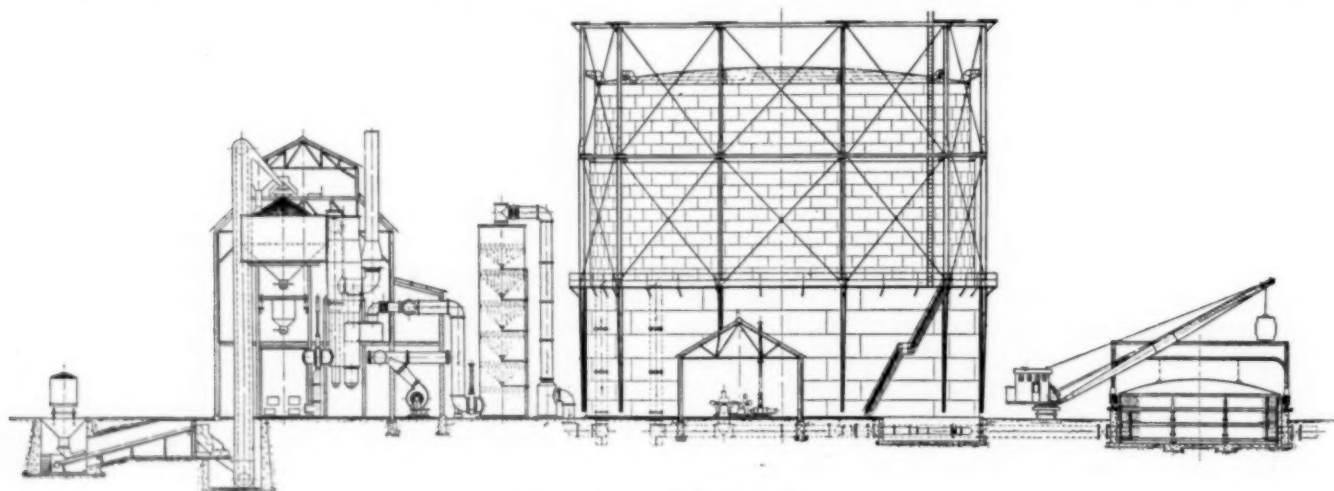
BLUE WATER-GAS PLANT

This is a diagrammatic presentation of a blue water-gas plant designed to supplement a natural gas supply. The Bartlett-Hayward Co. was the designer and builder of this equipment. Capacity, 12,000,000 cu.ft. per day..

constituents. We know virtually nothing of the shielding effect of one gas upon another and are similarly ignorant as to the influence of time and solid surface action upon these thermal chemical reactions.

Take the case of ammonia alone. We have perhaps the greatest fund of physicochemical information regarding this constituent of crude gas that we have for any of the important products produced by coal distillation. However, except for limited conditions, we know very little as to the influence of factors upon the yield of ammonia. We know vaguely that the presence of a certain amount of water vapor is important in order to protect the ammonia or to facilitate its formation. (No one knows just which it is.) However, we are not quite sure to what extent the higher moisture content of the coal charged is justified, because this would require rather accurate information to balance against the increased ammonia yield the simultaneous increase of fuel requirement for heating the retort or the oven.

The products of low-temperature distillation give great promise. But who knows what low-temperature tar oils are worth? No one apparently. As an important element in our future liquid fuel supply we cannot afford to ignore these liquid products of coal distillation. If we can achieve anything like the estimated yields of these products, say 40 or 50 gal. of liquid per ton of coal treated, the carbonization of large quantities of coal may be justified in order to secure these liquid fuel resources alone. However, until we know much more of the fundamental characteristics of the liquid constituents of crude gas as coming from coal we can neither have direct manufacturing processes for their production nor appreciate the utilization possibilities.

In the future it appears likely that the chemist will come to the mechanical engineer and say somewhat as follows: "Here is the coal we intend to use. We wish to subject it to a certain thermal treatment. We will specify for you the condition of the coal and quantities of the various products which must be handled. We will give you the limitations of temperature, both maximum and minimum, at each stage of the handling of the raw coal, the crude gas and the various products eliminated from the gas. Mr. Mechanical Engineer, you will design and build us a machine to carry through the process within these limitations." Then, and not until then, can the mechanical engineer intelligently and effectively design gas-making equipment.

Of course when that time comes doubtless the engineers and the financial interests will insist upon some measure of uniformity in the processes which the chemist will ask for. This will be only proper, for it will be no more reasonable to build a plant for a single coal than to build a house to suit all the peculiar ideas of one individual. If we build our gas plant for a single coal we place too severe a limitation of raw material which it must have. Nevertheless, recognizing this necessity for certain process uniformity, we will find a much greater variety in thermal history possible for the treatment of our fuels.
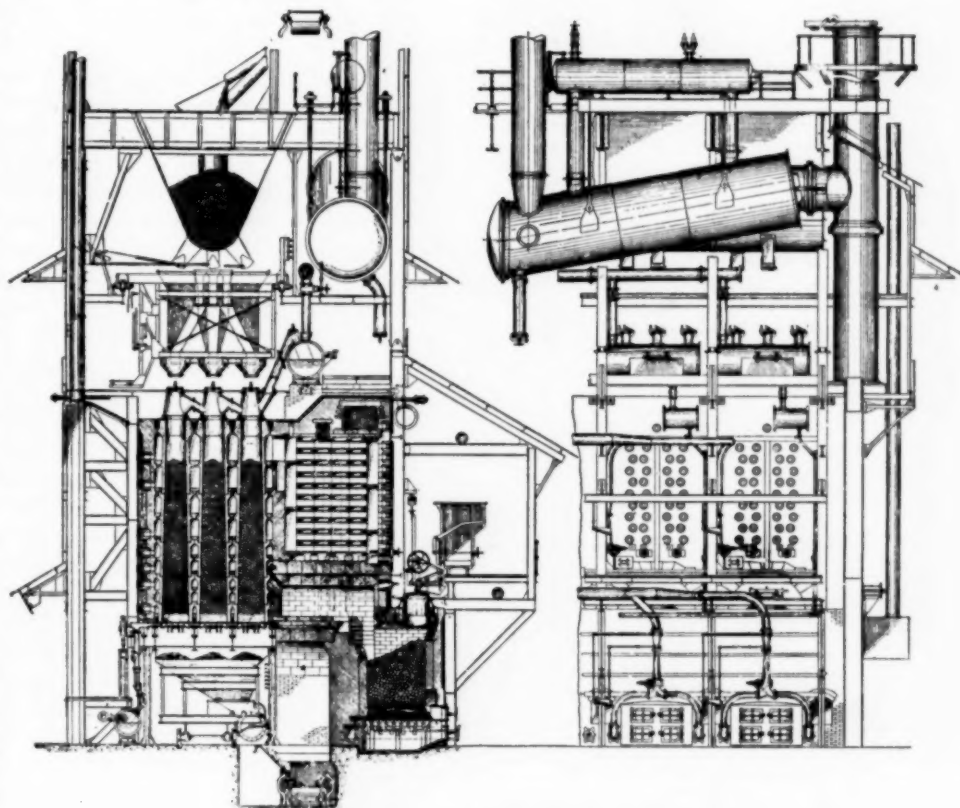
A MODERN VERTICAL RETORT PLANT

This installation shows diagrammatically a typical bench of six or nine retorts with waste-heat boiler, fuel handling, ash handling and producer gas heating accessories as built by the U.G.I. Contracting Co. It is one of several modern types, using intermittent vertical retorts.

The technology of electric power transfer over distances of 200, 300 and more miles is producing a great stir these days. We are talking about superpower systems, with the dispatching of current from one generating system to another system normally supplied by others, thus achieving wonderful advances in generating efficiency and power supply. At the same time natural gas transmission technology has been advancing. Today we have interconnected natural gas-transmission lines covering parts of eight states. Gas actually moves regularly from West Virginia to supply the city of Cleveland, and yet little attention has been given to these achievements. They are equally worth talking about.

Today there exists in western Pennsylvania, West Virginia and adjoining territory a supply of billions of tons of coal. It is a problem how to move the energy which this coal affords us to the seaboard, and into large industrial centers. There are three means to be used. We may move the solid fuel itself; this, of course, will be for many years to come the backbone of the transmission of energy from natural resource to the appliance of the user. However, we must take into account the possibility of generating gas by coking the coal, by gasification of the coke or by other yet undiscovered processes and the transfer of this gas to the industrial and municipal centers. The technology of
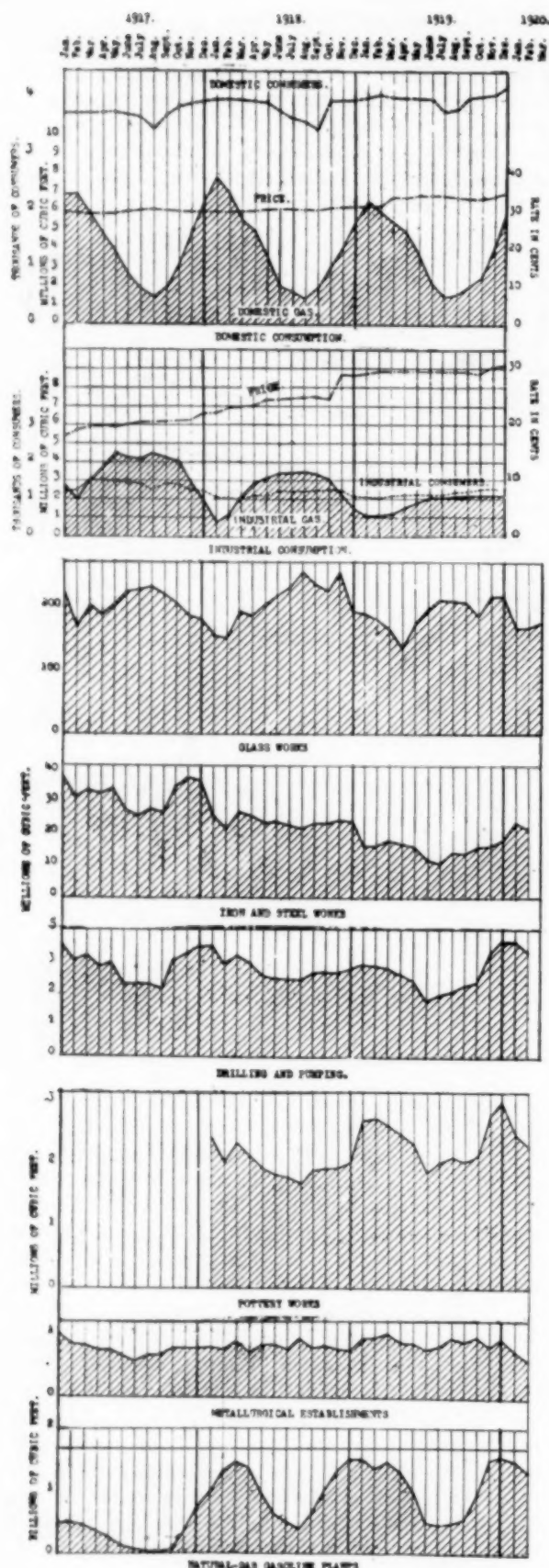
FLUCTUATING GAS DEMANDS BY MONTHS AND INDUSTRIES

Figures for domestic consumption, industrial consumption, glass works, iron and steel works, drilling and pumping, pottery works, metallurgical establishments and natural-gas gasoline plants.

The monthly fluctuation in gas demand of various industries here shown is one of the serious difficulties encountered by the gas business. With such fluctuating demands, costs are, of course, correspondingly high.

These data were prepared by E. G. Sievers of the U. S. Geological Survey.

this business is still young, but it is a thrifty, sturdy youngster.

We can move the coal as above mentioned, but in doing this one pound out of each four is consumed on the way for locomotive fuel simply to haul the remaining three. Judged on the basis of thermal efficiency, this, together with the low yield of heat in the ordinary coal-burning equipment, does not give us any very encouraging result to consider. Suppose instead of this we convert the maximum feasible amount of our fuel into gas and transfer the gas, say, 150 miles. This transfer, according to present none too good natural gas technology, requires only about 5 per cent of the energy for the movement of the remaining 95 per cent such distances as 100 to 150 miles. With careful study of the transmission problems, taking advantage of the latest developments in our knowledge of the physics of the flow of gas and of compression and with the mechanical engineering achievements surely to be expected in the coming decade, it is not too much to expect that the problem of energy transfer from resource to municipal supply will be accomplished by means of gas with an efficiency as great as if not greater than by any other medium. We have similar problems in the electrical business, where the finest of engineering talent is studying just how the balancing of loads, adjustment of load factor and power factor, and power line design will give us the greatest energy efficiency possible. The gas man may well take heed of this sort of investigation and development. With the fundamental advantage that gas can be generated with much higher thermal efficiencies than electric current can be generated by the use of any known processes of today, the gas engineer has much to encourge him.

Of course it would be foolhardy to assume that gas is destined to displace electricity. There is no need for such thought. The proper attitude is that gas and electricity are naturally supplementary, the one of the other. You might even call them "the gold-dust twins" of municipal energy and fuel supply. We need municipal fuel surveys in every large community or district. The total heating and power demands should be analyzed and the most effective means determined for meeting these needs. Gas, electricity and solid fuel will all have their share, of course, and it is important that they should work together to this end. For example, it is recognized as foolish in the present day for the gas industry to waste much time in the house- or industrial-lighting field. First of all, in this business we must have convenience, and there is no immediate prospect that gas can afford anything like the convenience of electricity in this particular work. Why, therefore, waste effort in trying to substitute gas for a more effective, more directly applicable medium? It is admitted to be far better to expend the effort which might thus be wasted on gas in persuading the householder or industrial plant manager to spend the money for any gas-burning equipment in lines where gas is an ideal fuel. For example, the cost of piping a house for gas light can much better be directed to the purchase of gas water-heating equipment or other modern effective devices that can be defended against all comers on the score of both efficiency and convenience.

GAS UTILIZATION AN IMPORTANT STEP

It is estimated that not more than 35 per cent of the natural gas delivered in the household is used effectively. In other words, nearly three times as much

service could be obtained from existing gaseous fuel supply in natural-gas territory were proper modern utilization methods pursued. From recent work done in several disinterested laboratories, it appears that this estimate and conclusion is amply justified. The reason for this rather appalling situation is not far to seek.

Until quite recently there has been no effort made in the scientific design of natural gas-burning equipment. A typical industrial-gas burner was a piece of pipe with a pipe cap on one end, a few holes drilled irregularly along its length and a smaller pipe projecting through the other end to supply the gas, perhaps with some means for controlling the air which entered between the smaller and larger pipes, very often no means at all being used for air control. Such device is a gas burner; it is more than this. It is a wonderful gas waster. Manufactured gas appliance manufacturers have not built quite as blindly as this, but some have almost done so. However, all are beginning to recognize that an appliance really does not burn gas. It burns a gas-air mixture. This at once impresses them with the fact that the appliance is a machine to make a mixture which it then subsequently delivers at the point where it is to be burned.

When appliance design reached this stage of interest in the production of air-gas mixtures, it was found that there was no information whatsoever as to the principles of air-mixer design. A few appliance makers have apparently studied the problem a little and have varied their appliance enough to give great improvement, but only recently have the fundamentals been considered. Within the past two years the first comprehensive, thorough work on this problem has been undertaken.

This work took up burner design in three parts. First, how to introduce the gas into the burner, maintaining in the gas stream the maximum of the kinetic energy possible; second, how to use this kinetic energy in building up a mixture, and third, under what conditions this mixture should be delivered to be most effectively burned and the energy of the flame utilized.

This work is only a beginning, however. It illustrates the necessity for study of viscosity, stream-line flow and momentum relations in burner design. The throat design must take into account both theoretical factors and practical matters of convenience in operation, ability of the operator to keep the appliance clean, etc. Already as a result of this work the appliance manufacturer can produce and handle almost "ideal" air-gas mixtures with low pressure gas. Formerly these possibilities were considered impossible without the use of air or gas under high pressure. By means such as this it will be possible to double or treble the efficiency of gas burning under many conditions, and as a result gas will be made available in many fields where before its relative higher cost per heat unit made it unavailable. Then, too, by simply better burner design, moving the burner closer to the kettle and teaching the householder a few simple principles, we shall find that manufactured gas at its much higher cost can replace natural gas, as these supplies decrease and finally disappear, without any increase in cost per month for service rendered above the expense to the householder for natural gas used as now so carelessly and inefficiently.

GAS AN INDUSTRIAL FUEL

Problems of industrial gas application are not limited alone to matters of appliance design. Here we have much the same situation as was described in the coking of coal. We need first to study the fundamentals of the industrial process. We must find out the thermal history to which we wish to subject our materials and then it will be possible quite easily to apply the gas for the production of the temperature-time relations which are desired. Metal melting, metal heat treatment, enameling, baking, boiling or heating the tea kettle all have their problems to be solved. When it is known just how these operations should proceed for perfect satisfaction, the means for accomplishment will quickly follow both in appliance design and in effective gas merchandising. Not only shall we find increased thermal efficiency resulting but it is not too much to expect that actual decreases in fuel cost will come despite the continued rise in the price of fuel raw material, and not only will these fuel advantages occur but there will also be built up opportunities for better quality of product, more uniform plant operation, more satisfactory conditions for work of the furnace and appliance operators, cleanliness of surroundings and numerous other advantages that always follow replacement of solid fuel by gas.

PRESENT LIMITATIONS

It would be foolish to close a discussion like this without pointing out one limitation which is just as serious as that of our present limitation of scientific knowledge. In this the matter of construction cost and the high cost of money are referred to. At the present time, even if we wished, it would be foolish to undertake to replace solid fuel by gas for extensive house heating or for other operations where the seasonal load curve is bad. Today it costs $2, $2.50 or $3 to build a plant where previously $1 sufficed. The public utilities that used to get money for such construction at 5 or 6 per cent because of the stable nature of their business now are fortunate if they can secure the money for 7 or 8 per cent. As a result, we have today capital charges, interest, amortization, taxes, all on a basis of about three times as much per unit of gas output. This, of course, places severe limitation upon the expansion of the gas manufacturing industry today, for it makes the capital charge element of gas cost almost as much as the total delivered price was formerly; and the operating expenses, too, are higher today than ever before.

On the other hand, solid and liquid fuel costs have advanced similarly. It is an old story to discuss our "thirty-cent" or "forty-cent" dollar in any market. It is not to be expected, therefore, that this financial limitation will permanently prevent improvement of the opportunity in the gas business. It is high time, therefore, to undertake all of that essential investigation in development work on fundamentals which will permit construction along right lines as soon as construction of any sort begins.

It should be recognized, too, that today the gas plants of the country are called upon to supply all or more than they can produce at seasons of maximum demand. Construction for the future, therefore, will be largely to supplement present capacities. We should not expect it for some years to come to be primarily a replacement of existing processes.

It is none too soon, however, to think of the new developments as being those which will be the backbone of the industry a decade or two from now. The great importance of their proper direction is thus at once evident.

Extraction of Calcium Oxide From Calcined Magnesite

L. H. DUSCHAK, chemical engineer, Bureau of Mines, has recently made a laboratory study of the extraction of the free CaO with water free from CO_2 from calcined magnesite. From the solubilities of $Ca(OH)_2$ and $Mg(OH)_2$, Seidell, "Solubility of Inorganic and Organic Compounds" (2nd Edition, 1919), it is estimated that at ordinary temperatures calcium hydroxide is fifteen to twenty times as soluble as magnesium hydroxide. It should, therefore, be possible to obtain a separation good enough for the purpose indicated by extraction with water.

SOLUBILITY OF $Ca(OH)_2$

Temp., Deg. C.	Grams per 100 g. H_2O	
	$Ca(OH)_2$	CaO
0	0.185	0.140
20	0.176	0.132
30	0.159	0.120
50	0.128	0.097
100	0.077	0.058

SOLUBILITY OF $Mg(OH)_2$ IN GRAMS PER LITER AT 18 DEG. C. BY CONDUCTIVITY METHOD

Solubility	Authority	Date
0.009	Kohlrausch & Rose	1893
0 008–0 009	Dupre & Brutus	1905
0 012	Tamm	1910

As some preliminary experiments indicated that the availability of the lime varied with the temperature of calcination, the majority of the extraction tests were made on material obtained by calcining portions of magnesite in a porcelain crucible at a fixed temperature for a definite time. The procedure commonly used for extracting the lime was to transfer the calcined material to a 200 c.c. graduated flask and add distilled water which had been freshly boiled to free it from CO_2. The flask was allowed to stand with occasional agitation for a fixed time, usually over night. The liquid was filtered if necessary, and a suitable volume, usually 100 c.c., was titrated with standard hydrochloric acid using phenolphthalein as indicator.

With the exception of a few experiments which will be noted below, the results in the accompanying table were obtained by the method just outlined.

A portion of the solution from test 14 was analyzed gravimetrically for CaO and gave a result corresponding to 4.5 per cent CaO. This shows that the alkalinity found by titration is due almost entirely to the $Ca(OH)_2$ in solution. This was confirmed by an experiment in which 3 g. of pure $MgCO_3$ and 0.150 g. $CaCO_3$ were mixed and calcined for one hour at 950 deg. C. The product was then leached with 300 c.c. water. Gravimetric analysis and titration on a 100-c.c. portion of this solution yielded the following results:

	Grams		Grams
MgO by grav	0 0008	CaO by grav	0 0280
CaO by titr	0.0307	CaO by calc	0 0280

In test 3 the calcined material was agitated with water for 3 hr. with CO_2 free air, and in test 15 there was similar agitation for 2 hr. It is evident that agitation in this way for 2 or 3 hr. is the equivalent of considerably longer leaching without agitation.

It will be noted that with the dead-burned magnesia and the magnesia bricks only a small portion of the CaO was found to be available, due, no doubt, to the high temperature of calcination. This influence on the tem-

Test No.	Material	Temp. Deg. C.	Time, Hours	Extraction of CaO, Solvent	Time, Hours	CaO Obtained	Total Present
1	Magnesite M-1 (Northwest)	900	½	H_2O	16	2.13	2.76
2	do.	900	1	H_2O	16	2.6	2.76
3	do.	900	1	H_2O	3	2.6	2.76
4	do.	900	1	5%NaCl	16	2.7	2.76
5	do.	900	1	5%NaCl	18	2.9	2.76
6	do.	900	1	5%NaCl	18	2.9	2.76
7	do.	900	2	H_2O	16	2.7	2.76
8	do.	900	2	H_2O	16	2.6	2.76
9	do.	950	½	H_2O	16	2.66	2.76
10	do.	950–1,000	1	H_2O	16	2.26	2.76
11	do.	950–1,000	1	H_2O	16	2.32	2.76
12	do.	1,000	½	H_2O	16	2.05	2.76
13	do.	1,050	½	H_2O	16	1.74	2.76
14	Calcined Magn. M-1-c	950	2	H_2O	16	4.6	5.3
15	do.	950	2	2%NaCl	16	4.5	5.3
16	do.	950	2	2%NaCl	16	4.7	5.3
17	do.	950	2	2%NaCl	16	4.6	5.3
18	Calcined Magn. M-4 (Hoff)	950–1,000	1	H_2O	16	3.13	4.28
19	do.	950–1,000	1	H_2O	16	3.07	4.28
20	Magnesite M-13 (Northwest)	900	½	H_2O	16	1.15	1.1
21	Magnesite M-13 (Northwest)	950	½	H_2O	16	1.23	1.1
22	do.	1,000	½	H_2O	16	0.98	1.1
23	do.	1,050	½	H_2O	16	1.19	1.1
24	Magnesite M-16 (Northwest)	950–1,000	1	H_2O	16	0.3	0.4
25	do.	950–1,000	1	H_2O	16	0.5	0.4
26	Magnesite M-18 Tulare	900	½	H_2O	16	0.76	0.6
27	do.	950	½	H_2O	16	0.67	0.6
28	do.	1,000	½	H_2O	16	0.72	0.6
29	do.	1,050	½	H_2O	16	0.63	0.6
30	White Rock	900	2	H_2O	16	0.87	0.7
31	Dead Burned MgO (White Rock)	1,400		H_2O	16	0.33	1.5
32	do.	1,400		H_2O	16	0.31	0.93
33	Magnesite Brick	1,500		H_2O	16	0.23	1.06
34	do.	1,500		H_2O	16	0.24	0.6

ANALYSES OF MAGNESITE SAMPLE USED FOR ABOVE TESTS

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO by Diff.	Ignition Loss
M-1	4.65	0.41	0.96	2.76	42.52	48.64
M-4	1.70	0.32	0.36	4.28	87.77	5.73
M-13	1.2	0.01	0.43	1.10	46.8	50.4
M-16	1.73	0.28	0.72	0.4	46.57	50.30
M-18	1.35	0.06	0.14	0.6	47.7	50.16

perature of calcination is also indicated in some of the tests at 1,000 and 1,050 deg. C. In order to determine whether the effect of calcination at high temperature was simply to decrease the rate of solution of the lime, a duplicate of test 13 was run, in which the calcined material was rolled with water for 5 hr. in a glass bottle containing glass marbles. The result was 1.76 per cent CaO, only 0.02 per cent greater than with the ordinary method of leaching. Grinding in this way was tried with several other samples, including some of the dead-burned material, without increasing the amount of soluble lime. This would indicate that calcination at high temperature causes the CaO to enter into some compound which is not decomposible by water.

Research and the Production of Leather Belting

Tribute is paid to the service the chemist has performed in the manufacture of leather belting, in a recent issue of the *G. W. W. Bulletin*, the house organ published by Gaston, Williams & Wigmore, Inc. Speaking of the Graton & Knight Manufacturing Co., of Worcester, Mass., the *Bulletin* says:

"A large and completely equipped chemical laboratory was established by this company a number of years ago and has consistently availed itself of every scientific discovery tending to increase quality. A staff of chemists under a chemical authority on tanning is constantly at work. All raw material is tested and in addition much work of an experimental nature is done in tannage, currying and other processes."

The Post-War Status of the Ceramic Industries*

An Outline of the Need for Reducing the Fuel Consumption and for the Introduction of Labor-Saving Devices, With a Short Review of the Economic Status in the Manufacture of the Various Clay Products

By A. V. BLEININGER

THE general perplexed condition of American industry extends of course to the silicate industries, dealing with the manufacture of the various clay products, glass and enamel metal ware. The railroad situation, the lack and high cost of fuel and the acute labor conditions are responsible for the most difficult situation which has ever confronted these industries. The two primary aims of the manufacturers must of necessity be to reduce the fuel consumption and to strive for the introduction of labor-saving devices. The first part of this program is being attacked through the use of the continuous and especially the tunnel-car kiln. Rapid progress is being made along these lines and a considerable number of such kilns are being built. The adaption of the tunnel kiln to the manufacture of heavy structural products in large tonnages has not yet been completed and the problems of the successful water-smoking and oxidation of such products still awaits complete solution.

The introduction of the tunnel kiln is undoubtedly one of the most important advances ever made by the industry and means not only a saving in fuel of not less than 50 per cent but a reduction in the labor cost as well. It is interesting to note that the metallurgical and allied industries are awakening to the advantages of this type of furnace and are adopting it for calcining and annealing operations.

There are two types of tunnel kilns to be considered —one in which the gases come in direct contact with the charge and the other in which the heat is transmitted through the walls of combustion chambers. The former type requires the use of saggers for the burning of glazed ware, but in the latter the articles may be set unprotected. These kilns have also been built of the twin type consisting of two adjoining tunnels through which the cars pass in opposite directions. Progress is being made with reference to the use of producer furnaces attached to the kilns and the employment of mechanical stokers. A considerable number of tunnel kilns are now in operation and maintain temperatures as high as 1,450 deg. C.

Labor-saving devices, especially with reference to the more economic handling of raw materials, mechanical driers, automatic molding machines, etc., are being introduced rapidly in the different industries.

BUILDING AND PAVING BRICK

The high cost and scarcity of labor, the difficult freight situation and the extraordinary increase in the price of coal have had a strong depressive influence especially on the plants compelled to ship their product. The prices of the product have gone up to unprecedented levels through the enormous increase in the cost

of manufacture. The difficulty of securing labor has been a very important factor, since the hard manual labor of the brick yards does not attract the best workmen. Altogether the building and paving brick industries are laboring under serious difficulties. This applies still more strongly to the paving brick industry, dependent as it is upon road improvements and new projects for which municipalities find it difficult to obtain the money. The demand for brick products is fundamentally strong and is bound to be great for at least the next five or ten years.

BUILDING TILE AND SEWER PIPE

The demand for hollow building tile is increasing very rapidly with the enlarged use of stucco construction and the plants have ample orders. They, like the other structural clay products industries, are seriously handicapped by the prevailing conditions.

The sewer pipe industry, like the manufacture of paving brick, is hampered by the difficulties in the way of carrying out municipal improvements.

TERRA COTTA

This industry after its dormant existence during the war has revived considerably and is certain to regain its pre-war status as soon as the conditions permit it. The manufacturers are making rapid progress in the development of superior bodies and techniques. In one establishment the tunnel car kiln is being used, a step which is being watched with considerable interest.

In the Middle West States the question as to the feasibility of washing the terra cotta clays is being discussed and may lead to the erection of central preparing plants.

FLOOR AND WALL TILES—POTTERY

Manufacturers of floor and wall tiles have been considerably hampered by the general obstructions to industrial activity and the labor situation, so that it has been difficult to maintain even approximately normal conditions.

The pottery industries have suffered particularly with reference to their supply of raw materials, especially feldspar. This condition has become very serious, and for this reason increasingly large quantities of soda feldspar are being introduced in the body. In addition to these difficulties the question of the fuel supply has become very critical, especially in the districts where natural gas is no longer available. Unheard-of prices are being paid for coal in the eastern pottery districts.

A report issued some time ago jointly by the U. S. Potters' Association and the Bureau of Standards brings out the fact that the domestic kaolins are suitable for the manufacture of white ware pottery, but that at the present time the supply of primary kaolin is not sufficient

to meet the needs of the industry. The use of imported English china clay therefore cannot be dispensed with until additional sources are developed in this country.

The demand for high-grade domestic porcelain tableware is constantly increasing and is being met by the enlargement of a number of potteries and the erection of new plants.

The tunnel kiln is rapidly establishing itself as a permanent feature of potteries, a situation very much to be desired.

ELECTRICAL PORCELAIN

The newer developments tend toward the more extensive introduction of the casting process in the making of high tension porcelain and the employment of somewhat higher burning temperatures.

More critical tests are being employed in the examination of the porcelain structure, such as by the penetration of alcoholic eosine solution under pressure, and the quality of the material is being raised generally. Extensive researches are being conducted by a number of concerns which strive for improvement in the product.

In the manufacture of spark plugs the quality has been pushed to a high degree of perfection and there is no doubt that these motor accessories are decidedly superior to the European product. High temperatures, about 1,450 deg. C., are employed in the firing, and tunnel kilns have been successfully adapted to this purpose.

CHEMICAL STONE WARE

This industry has been established on a firm basis and has made the United States independent of European products. Both as to quality of the material and the technique of producing intricate shapes the standards are very high.

THE GLASS INDUSTRIES

The demand for glass products of all kinds is very great and is not being adequately supplied, due to conditions beyond the control of the industry. The deficiency in fuel supply has been a serious drawback to production. The elimination of natural gas has made it necessary to equip many plants with exceedingly large and expensive producer gas plants and to adapt the tank practice to this fuel.

The activity in developing new mechanical processes has been particularly marked, especially in the manufacture of window glass and hollow ware. The methods of drawing straight sheets from the molten glass, the automatic feeders and presses, and tube drawing machines have all contributed toward lowering the excessive labor cost connected with the old practices. Incidentally it might be said that the wages of the glass operatives have gone up to high figures, so that it is not unusual to find gathering boys receiving earnings at the rate of $2,000 per year. Improvements have also been made in the preheating of the pots and the installation of the tunnel kiln for this purpose.

ENAMELED METALS

The manufacture of enameled cast-iron and steel products has been handicapped by difficulties in securing raw materials, especially feldspar and cryolite. Enameling processes are being applied to an ever-increasing number of articles, and as a result the industry is expanding rapidly. From the research point the results of the work done by the Bureau of Standards on the subject of "fish scaling," a common defect, are of importance and it can be safely predicted that this source of loss can soon be eliminated.

REFRACTORIES

As compared with war-time activities the demand for these products is small in volume, though the plants are continuing operations as regularly as is possible under the prevailing conditions. The demand for special refractories of high quality is very good and there are strong indications that considerations of quality will in the future govern sales to a much greater extent than they did in the past. It is being realized more and more that the first cost of refractory materials is secondary to quality. The work of such organizations as the American Society for Testing Materials in advocating specifications for refractories is bringing returns and users are coming to realize the importance of having definite requirements.

Basic refractories are still being made from American magnesite and the prospects are fair that the Washington deposits will remain a permanent source.

Work in connection with the further development of improved materials for electric furnaces is in progress. The use of silicon carbide as a refractory has made rapid strides.

In the manufacture of graphite crucibles it has been shown by the Bureau of Mines that American clays of the ball clay type are as well suited for the purpose as those formerly imported from Germany and in some respects are superior.

The refractories used in the glass industry are still being made to a large extent from domestic raw materials, though some shipments of Gross Almerode clay have been received. Considerable progress has been made in connection with the improvement of tank block compositions and firing treatments which should yield longer tank life.

RESEARCH WORK

It is gratifying to note the realization on the part of the manufacturers that industrial research has a real money value and the demand on the part of the industries for young men trained in ceramic engineering has been greater than the supply. Many concerns have established works laboratories when formerly they could not be interested in activities of this kind. In several instances associations of manufacturers have established either a joint laboratory or are supporting research fellowships.

ASSOCIATIONS

A very important factor in developing the new spirit of co-operation has been the associations of manufacturers, such as the National Terra Cotta Society, the National Paving Brick Association, the Hollow Tile Association, the Common Brick Manufacturers' Association, the U. S. Potters' Association and others.

From the standpoint of technical development the American Ceramic Society has undoubtedly been the most important factor. The creation of divisions representing the several branches of industry has been a notable step in bringing about closer co-operation between the manufacturer and the technical man and the scheme is already yielding good returns. The society has been fortunate in the wide vision of its officers, who have seen the opportunities for greater service and have grasped them.

Products From Dry Distillation of Matita Asphaltum*

By C. Nicolescu-Otin

BITUMEN is a very complex substance, and to be able to examine the properties of its constituent parts, it must be subjected to a distillation process. Materials are thereby obtained which do not exist as such in the original, but are split off during the course of the destructive distillation and which permit us to see the nature of the complexity of the bitumen.

The distillation took place in retorts, made of earthenware and iron, and the temperature was measured with a Le Chatelier pyrometer. Various gaseous, liquid and solid products were obtained. At the beginning of the distillation, the evolution of much water vapor was remarked, which comes from the water that is mechanically combined. Then, when the temperature increased to 400 to 460 deg. C., large quantities of a bluish-gray gas were produced. This gas contained considerable H_2S.

As the temperature increased, the gas gradually lost its color, and around 730 deg. C. its content in H_2S and water vapor had changed, due to the molecular decomposition that had taken place.

The gas contains about 1,500 l. of H_2S in 180 cu.m. —the quantity obtained from one ton of the bitumen— and possesses the following composition: 12.1 per cent CO_2, 2.6 per cent C_nH_{2n}, 1.9 per cent O, 13.1 per cent CO, 29.8 per cent H, 34.7 per cent CH_4 and 5.4 per cent N.

The asphaltum contains 0.88 per cent N, of which 24 per cent is recovered in the ammoniacal liquors as NH_3. This means that for every ton of bitumen there is obtained 2.5 kg. of NH_3 or 10 kg. of sulphate of ammonia. This quantity is almost equal to the yield procured from coal.

The solid residue, left in the retort after distillation, consists of the mineral part of the asphaltum, mixed with 5.6 per cent very fine carbon. The most valuable product of the distillation is the tar, which represents about 46.6 per cent of the weight of the bitumen. The tar is olive colored and holds in suspension very finely divided carbon. It has been noticed that the iron of the retort facilitates the decomposition of the tarry vapors, producing thereby a lesser quantity of tar—47 per cent—with more carbon in suspension—1.7 per cent—in comparison with the yield obtained in an earthenware retort, 56 per cent tar and 0.6 per cent carbon in suspension. The tar has a specific gravity below unity, varying between 0.908 and 0.930 at 18 deg. C., indicating that it must contain a large quantity of hydrocarbon oils and paraffines.

FRACTIONAL DISTILLATION OF THE TAR

The fractional distillation of the tar, first up to 310 deg. C. under normal pressure and then between 200-275 and 275-310 deg. C. under a vacuum, yielded fractions, with the corresponding specific gravities, are given in Table I.

Furthermore, these fractions were analyzed to find their ultimate composition and the iodine, saponification and total acidity numbers were determined. The results are given in Table II.

TABLE I

Fraction	Per Cent of Tar	Specific Gravity
Up to 170°	6 23	0 7900 at 20°C.
170–230°	9 73	0 8420 at 20°C.
230–270°	9 45	0 8770 at 20°C.
270–310°	10 70	0 8990 at 20°C.
200–275°	15 90	0 9425 at 25°C.
275–310°	5 55	0 9725 at 25°C.
Above 310°	23 96	1 0060 at 15°C.

TABLE II

Fraction	%C	%H	%N	%S	%O	Numbers — Iodine	Sapon.	Total Acidity
Up to 170°C.	83 73	12.66	0.41	0.11	3.09	150.85	12 31	2 74
170–230°C.	84 94	11.51	2.52	0.06	1.42	101 06	14 65	4 71
230–270°C.	85.28	11.86	0.87	0.09	1.90	62 47	20 12	10 12
270–310°C.	84.27	10.96	1.24	0.09	3.44	51 29	12 34	0 68
200–275°C.	81.67	11.57	2.42	0.38	3.96	34 54		
275–310°C.	85.18	10.89	1.22	0.42	2.29	31 63		

The oxygen was determined by difference.

These results indicated that the elements entering into the composition of the bitumen, namely, C, H, S, N and O, are found in all the fractions; that the saponification and acid numbers are relatively small, but that the iodine numbers are large, indicating a considerable proportion of non-saturated cyclic and aliphatic hydrocarbons; that the quantity of these compounds present diminishes as the ebullition point increases.

To determine the quantity of non-saturated cyclic hydrocarbons in relation to the non-saturated aliphatic hydrocarbons contained in the fractions, the Nastjukoff reaction was used, whereby the formolite number was found by means of formaldehyde. The formolites themselves were also analyzed and the combined results are given in Table III. As in Table II the O percentages are found by difference:

TABLE III

Fractions	Formolite Number	Composition of the Formolites, per Cent — C	H	N	S	O
Up to 170°C.	42.55	71.50	10.01	2.90	1 58	14 01
170–230°	36.25	73.37	11.64	4 11	1 57	9 31
230–270°	48.50	74.25	10.35	5.38	0 97	9 05
270–310°	72.16	77.15	11.58	4.67	0.96	5 64
200–275°	35.33	73.88	10.67	3.50	1 30	10 65
275–310°	38.90	78.25	10.35	4 15	1.03	6 22

From the above, it is seen that the formolite numbers are relatively small and that the formolites contain the five elements C, H, S, N and O, which are found in the sulphonated derivatives of the original products, which substances contained S and N and probably O as well in their molecules.

In order to substantiate our conclusion that the formolite reaction eliminates all the compounds containing N, S and O from the fractions, the liquid residues were analyzed and were found to contain C and H only. The results are given in Table IV.

TABLE IV

Fraction up to	170° C.	170–230°	230–270°	270–310°	200–275°	275–310°
Per cent C	86.90	87.27	87 12	87.35	86 62	86 12
Per cent H	12.82	12.62	12.76	12.39	12 92	13 36

The exact ratios between the cyclic and non-cyclic unsaturated hydrocarbons present in the original fraction can be determined by means of the iodine numbers of these very residues, by taking the difference between these numbers and the iodine numbers of the fractions. They are given in Table V.

TABLE V

Fraction	Up to 170°C.	170–230°	230–270°	270–310°	200–275°	275–310°
Iodine number of original fraction.	150.85	101.06	62.47	51.29	34.54	31.63
Iodine number after the formolite reaction.	34.78	43.01	22.44	23.69	24.07	19.95
Difference	116.07	58.05	40.03	27.06	10.47	11.68

As may be seen from the above, the unsaturated cyclic hydrocarbons predominate in the fractions having the lower boiling points, while the unsaturated non-cyclic hydrocarbons are predominant in the higher boiling-point fractions.

THE COMPOSITION OF MATITA ASPHALT

The researches of Prof. Charitskoff of Tiflis (*Chem. Zeit.*, 1912, p. 1,402), who examined the fractionated products of asphaltic tar and petroleum from Grosny, led him to conclude that the petroleum was a decomposition product of the asphalt. The author undertook a series of researches to establish the relation between the origin of Matita asphalt and petroleums. The petroleum that was used had a specific gravity of 0.902 at 20 deg. C. and contained 85.60 per cent C., 13.64 per cent H, 0.35 per cent N and 0.07 per cent S. On fractionation, the following products were obtained:

Up to 150 deg. C., 35 per cent by volume was distilled over, with a specific gravity of 0.721 at 20 deg. C.

From 150 to 300 deg. C., 33 per cent by volume, specific gravity, 0.817 at 20 deg. C.

Residue above 300 deg. C., 32 per cent by volume, specific gravity, 0.948 at 20 deg. C.

As can very well be seen, the petroleum fractions differ radically from the tar fractions, both in quantity and density. However, to compare them better, the saponification and iodine members have been determined for the oil fractions as well and are given in Table VI.

TABLE VI

Fractions	Saponification Number	Iodine Number
Up to 150°C.	1.30	1.88
150–300°C.	6.87	3.27
Above 300°C.	7.76	12.86

It is at once evident that the saponification and iodine members of the petroleum fractions—and hence of the oil itself—are much smaller than those of the corresponding tar fractions, indicating a very small proportion of saponifiable compounds and unsaturated cyclic and non-cyclic hydrocarbons. This constitutes the primary difference between the tar and the petroleum.

The Nastjukoff reaction was employed, as in the case of the tar, to determine the cyclic : non-cyclic ratio and the analysis of the formolites gave the results shown in Table VII.

TABLE VII

Fractions	Formolite Number	%C	%H	%S	%N	% O (by Difference)
Crude oil	22.13	64.83	11.11	4.55	4.08	15.43
Up to 150°C.	4.60	79.61	10.88	1.48	2.06	5.97
150–300°C.	21.38	77.20	9.89	1.97	1.90	9.04

Here also it is seen that the formolite members are smaller than those of the corresponding tar fractions, but that, just as in the latter case, the formolites contain the five principal elements C, H, N, S and O found in the sulphonated derivatives of all the original products which have S, N and O in their molecules.

To corroborate our theory that formaldehyde refines the petroleum, an analysis was made of the liquid residue remaining after the treatment of crude oil with formaldehyde. The analysis showed the residue to contain only C and H (85.98 per cent C and 13.39 per cent H).

The ratio between the unsaturated aromatic and aliphatic hydrocarbons was found by taking the iodine numbers of the crude petroleum and of the liquid residue from the formolite reaction. The results follow:

	Iodine Number
Crude petroleum	6.02
Liquid residue	3.75
Difference	2.27

Hence the proportion of unsaturated aliphatic hydrocarbons (3.75) is greater than that of the aromatic (2.27), which is contrary to that of the tar, where the aromatic type is predominant. In the case of the lower boiling-point fraction, this difference is even more pronounced.

CONCLUSION FROM THE RESEARCHES

The conclusions that may be derived from these researches are as follows:

1. The fractionated products of the tar are comparatively much less in quantity at the lower temperatures than in the case of the petroleum. This indicates that the original hydrocarbons in the petroleum have been subjected to a strong polymerization, which was caused by the oxygen in the air and was a gradual process, particularly facilitated by the fact that the petroleum, distributed throughout the sandy argillaceous rock, offers a very large reaction surface. Compounds of heavy molecular structure are formed in this way, which results in the elevation of the boiling point.

2. The same conclusion is reached from a consideration of the fact that the saponification numbers of the tar fractions are greater than those of the oil fractions. The oxygen in the air has polymerized the hydrocarbons, producing saponifiable compounds of various nitrogen bases, which characterize the bitumen.

3. The presence of large quantities of aromatic hydrocarbons in the tar fractions substantiates the contention that the bitumen is a product of the petroleum, for it is well known that by means of oxygen, pressure, temperature and especially time, saturated aliphatic hydrocarbons are transformed into non-saturated aromatic hydrocarbons. Such a transformation can be made to take place in the laboratory on the petroleum residues.

4. The tar products are characterized by relatively large proportions of S and N, which explains once more the molecular polymerization of the petroleum constituents.

From this study of the experimental results, it can be stated with certainty that Matita asphaltum was formed during the geologic ages by the polymerization of the hydrocarbons contained in Matita petroleum, distributed throughout the sandy argillaceous and shell-bearing marine deposits. Accordingly, its primordial origin is identical with that of the petroleum.

GENERAL CONCLUSIONS

The following general conclusions may be drawn from this general study of Matita asphaltum:

1. Matita asphaltum, found in quite large quantities

—valued at 30 to 35 million francs—should constitute a source of exploitation of the first rank, because of its superior qualities as an asphalt, its high bitumen content (29 per cent), as well as for the favorable transportation conditions.

2. Matita asphaltum, when dry distilled, produces a combustible gas, which resembles that obtained from lignites in composition and yield (about 180 cu.m. per ton of bitumen).

3. The dry distillation yields about 10 kg. of $(NH_4)_2SO_4$ per ton of bitumen, 24 per cent of the N in the bitumen being recovered as NH_3. The $(NH_4)_2SO_4$ yield is equal to that obtained from coal.

4. The coke procured in the dry distillation may be used in the refining of petroleum in place of florida earth. In any case it can be used as a ballast.

5. The tar has a specific gravity below unity and at least 120 kg. of it is obtained from every ton of asphaltic rock, or 450 kg. per ton of bitumen. This is an extraordinarily large quantity, and offers a fine source of profit, as it contains, especially in the lower boiling-point fractions, a high percentage of aromatic compounds, as well as a large amount of paraffine and hydrocarbon oils in the higher boiling-point fractions (the 200-275-deg. fraction contains 30 per cent paraffine). There is hence presented the possibility of manufacturing several explosives and there is here a precious source of paraffine, petrolatum and mineral oils of high quality.

6. The researches on the geo-chemistry of Matita petroleum and asphaltum have undoubtedly proved the latter to be a polymerization product of the former.

Steel Wizards, Past and Present

Professor Sauveur's Address Before the American Society for Steel Treating, in Which He Makes a Plea for More Important Contributions to the Art of Making Steel by American Metallurgists and Researchers

By ALBERT SAUVEUR*

WE ARE rightly proud of our achievements, of the wonderful steel industry of our country, of our leading position as the greatest iron- and steel-producing nation in the world, but lest we forget what we owe to the steel wizards of other lands it will be salutary to recall their deeds. It will keep us from too complacent an attitude toward other metallurgical nations reporting smaller tonnage. It should stimulate in us a desire to contribute more substantially to the progress of the art in which we are interested.

We have been eminently successful. Our iron and steel industry has added vastly to the wealth of the nation. A book has been written entitled "The Romance of Steel; or, The Making of a Thousand Millionaires." Our business men, our captains of industry, our financial wizards have played their parts most successfully. Can the same tribute be paid to our scientific and technical wizards? Have they played their parts, or have they been satisfied with following the tracks of wizards of other nations? Can they be accused of parasitic tendencies?

I should first describe what I have in mind by steel wizards. I mean those men who have contributed the great basic inventions upon which the iron and steel industry is founded—men like Huntsman, Cort, Réaumur, Bessemer, Abraham Darby, Tschernoff, Osmond, Le Chatelier, Sorby, Howe—men whose discoveries, inventions or scientific contributions are epoch making.

Our Contribution Chiefly Labor-Saving Devices

Is it not true that although being by far the greatest iron- and steel-producing country we have not contributed our share of these great inventions, discoveries and scientific achievements? Is it not true that our contributions have been chiefly of a mechanical kind, that they have consisted in the main in labor-saving devices and machinery destined to cheapen and speed up production? In this we have been undoubtedly successful and the importance of speeding up and cheapening production is not to be denied or belittled, but should we be satisfied with great advances in this direction only?

American mechanical wizards have passed through our steel plants and have left their marks, but do we not look in vain for evidences of the passage of American metallurgical wizards?

Is it not true, and is not the thought somewhat humiliating, that if all the contributions of American metallurgists and scientists to the art of making steel had never been made, iron and steel would continue to be manufactured, worked and treated practically as they are today, in reduced proportions to be sure, but of unimpaired quality? Is it not also true that if the contributions of English metallurgists and scientists were withdrawn the entire structure of the iron and steel industry would ignominiously collapse? We would have neither puddling furnaces, nor crucible steel, nor bessemer steel, nor open-hearth steel, nor rolling or forging appliances.

We make more pig iron than any other country, but the blast furnace was neither invented nor developed in the United States. We have discarded the expensive fuel charcoal, but this was first done by the Englishman Dud Dudley in 1619. We make more coke and use more coke for iron making than any other nation, but coke was first made and first used as a blast-furnace fuel in England by Abraham Darby, who in 1735 had the inspiration of treating coal as the charcoal burners were treating wood.

More waste gases issue from our blast furnaces than in any other country, and possibly we utilize them

more thoroughly, but this has been made possible by the invention of metallurgists of other nations: by Aubertot in France, who in 1811 took a patent for the utilization of the waste gases; by James Beaumont Neilson of Glasgow, who in 1828 first suggested the use of hot blast; by Robert du Four in France and James Palmer Budd in England, who in 1833 and 1845 respectively suggested the heating of the blast by burning waste gases; by Philip Taylor in England, who in 1840 suggested the closing of the top of the furnace that the waste gases might be collected; by G. Parry of England, who in 1850 invented the bell and hopper or cup and cone as a means of closing the top of the furnace; and by the Englishman E. A. Cowper, who in 1860 introduced the use of regenerative brick stoves. We have now, I believe, a greater number of gas blowing engines than any other country, but the internal-combustion engine using blast-furnace gas was developed at Seraing in Belgium and we were at first quite reluctant to adopt it.

As notable improvements in blast-furnace operations we may claim, I believe, the automatic loading by skip cars and inclined planes and the double bell and hopper which that method requires.

We make more wrought iron than any other country, but the reverberatory puddling furnace was invented in England in 1784 by Henry Cort and the wet puddling process was introduced in that country also by James Hall and S. B. Rogers about 1830.

In the Steel Industry

We have a very important crucible-steel industry, but crucible steel was first made by an English clock maker, Huntsman, in 1740, while the method we follow by which we do away with the necessity of using blister or converted steel was introduced by the Englishman Mushet in 1801.

We are making more bessemer steel than any other nation, but the bessemer converter and its necessary equipment was invented in 1856 by the illustrious Bessemer, an Englishman of French parentage, and the bessemer process was made successful by Robert Forrester Mushet, another Englishman who discovered the necessity of adding spiegeleisen or manganese in some other form.

The basic bessemer process, in which, to be sure, we are little interested, resulted from the masterly investigation and study of two Englishmen, Sidney Gilchrist Thomas and his cousin Percy C. Gilchrist, in 1878.

We make more open-hearth steel than any other country, but the regenerative furnace is not an American invention and open-hearth steel was first made by the French metallurgist Emile Martin in 1865.

We are, if I am not mistaken, making more electric steel than any other country, but we took practically no part in the development of the electric furnace for steel making, the furnace we most use being the invention of the French metallurgist Héroult.

We make more ferro-alloys and more special or alloy steels than any other nation, but the most important of these with the exception of high-speed steel we owe to the labor of metallurgists and scientists of other countries.

Our yearly tonnage of malleable castings is very much greater than that of any other nation, but the invention of the process is to be credited to the illustrious French chemist Réaumur, who described it in 1722. To him

also we owe the first scientific study and disclosure of the cementation and case-hardening processes.

We roll and forge more steel than any other nation, but with the important exception of the three-high rolling mill, rolling and forging appliances were not invented by us. The two-high pull-over grooved mill was invented by Cort; the reversing mill in 1866 by Ramsbottom in England; the universal mill is a German invention; the continuous mill was invented in 1861 by the Englishman Charles While, although it has been much improved by the American engineers Bedson and Morgan. We owe the steam hammer to the genius of two Englishmen, James Watt and James Nasmyth, and hydraulic presses to the Englishmen Bessemer and Gledhill.

We treat a larger tonnage of steel than any other country, but can we claim that the scientific investigations which have lifted the art of treating steel to such high degree of perfection are due chiefly to American metallurgists and scientists? Is it not true that with the exception of the invaluable contributions of Prof. Howe the work has been done chiefly in Russia by Tschernoff, in England by Sorby, Roberts-Austen, Arnold, Stead and Rosenhain, and in France by Osmond, Le Chatelier, Guillet, Charpy, Portevin, Chevesnard and Grenet?

High-Speed Steel the Exception

The discovery of high-speed steel, or, if you prefer, of the treatment imparting high-speed properties to certain steels, by F. W. Taylor and Maunsel White, I am inclined to consider as our one epoch-making contribution to the metallurgy of steel. I am well aware that some have tried to throw doubts on the novelty of this discovery, but in my opinion their contentions are not only ungenerous but unjustified. It continues to shine as the brightest American star of the metallurgical sky.

America's Roll of Honor

On a roll of honor for notable inventions, discoveries or improvements in the art of making, working or heating iron and steel or for notable and fruitful scientific contributions to that art, the following Americans are, I believe, entitled to a place:

H. H. Campbell, for designing the first tilting openhearth furnace.

John Fritz, for his invention of the three-high rolling mill.

James Gayley, for conceiving and executing the drying of the air blown into blast furnaces.

A. L. Holley, for notable improvements in the construction of bessemer mills.

Henry M. Howe, for his invaluable scientific contributions to our knowledge of steel.

Robert W. Hunt, for his pioneer work in bessemer steel and in steel-rail manufacture.

W. R. Jones, for introducing the use of mixers in steel making.

Julian Kennedy, for notable improvements in the construction of blast furnaces and of blast-furnace equipment.

F. W. Taylor and Maunsel White, for their epochmaking discovery of high-speed steel.

Samuel T. Wellman, for notable improvements in the construction of open-hearth furnaces, for designing and constructing charging machines and other useful appliances.

Frederick W. Wood, for his introduction of the car-casting method for steel ingots.

CONCLUSION

The natural conclusion of my remarks must be a wish that we may become more prolific in steel wizards of the first order—that is, in metallurgists who will **not** be satisfied in merely speeding up production through ingenious labor-saving and other devices, but who will bend their energy and talent toward the discovery of new and epoch-making methods of producing, working and treating steel that we may in future, as the leading metallurgical country, contribute our full share to metallurgical progress.

Additional Technical Papers From Steel Treaters' Convention

IN THE last issue of CHEMICAL & METALLURGICAL ENGINEERING (vol. 23, p. 565, Sept. 22, 1920) there were presented brief abstracts of a few of the papers read before the first meeting of the American Society for Steel Treating. Lack of space and exigencies of publication made it necessary to hold over Prof. Sauveur's address, as well as the following abstracts gathered during the technical sessions.

FATIGUE STRENGTH OF CARBON SPRING STEEL

An important paper on the effect of heat treatment on the fatigue strength of steel was read by E. P. STENGER and E. H. STENGER, covering an investigation of spring steel made at the Sheldon Spring & Axle Works. They notice that fatigue failures are somewhat similar to failures in brittle material in that they occur with suddenness and show no deformation. Brittle metals, however, have a uniform-grained fracture, while laboratory and service failures under fatigue show a larger or smaller area of fine-grained "detail" fracture near the point of maximum stress surrounded by coarser grain.

After defining fatigue strength as the number of repetitions required to produce failure at a given stress, the authors reviewed the literature and listed the following facts which are known about the fatigue strength of steel:

First, the number of repetitions required to cause failure has a logarithmic relation to the maximum unit fiber stress. It is especially noted that there is no break in the curve at the elastic limit.

Second, the number of repetitions to cause failure depends upon the range of stress—that is to say, upon the difference between the maximum and minimum stresses imposed upon the steel. There is a certain range which will allow an infinite number of repetitions without failure, but this range narrows as the maximum stress increases.

Third, the fatigue strength is independent of the speed up to 2,000 per minute.

Fourth, rest and repeated tempering below Ac_1 does not increase the endurance of unhardened steel.

Fifth, cold work affects the fatigue strength variously.

Sixth, endurance of metal shows a maximum when the metal is held at from 300 to 400 deg. C.

Seventh, the endurance of carbon steels is greatest with hardened eutectoid steel.

The authors describe in detail the heat treatment and preparation of samples in their research upon a carbon spring steel containing the following analysis: Carbon 1.03 per cent, manganese 0.45 per cent, sulphur 0.025 per cent, phosphorus 0.026 per cent. They conclude that the shape factor is of great importance because it gives a non-uniform disposition of internal loads with stresses highly concentrated at certain points. Again, the condition of the external surface, whether impaired by the gases of the heat-treating operation or ground clean, has an enormous influence upon the fatigue strength of the sample. Results of their systematic tests on this carbon steel are plotted in Fig. 1, from which many inferences may be drawn.
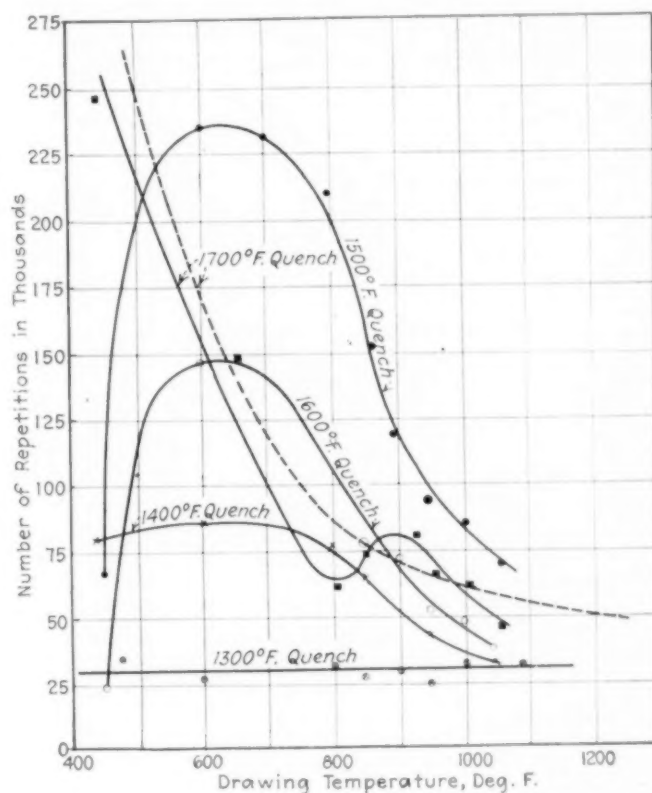
FIG. 1. ENDURANCE OF CARBON SPRING STEEL AFTER VARIOUS HEAT TREATMENTS

Two curves are shown for the 1,700 quench. The authors are of the opinion that a parabolic curve such as the dotted one may be more reliable than the full line following the points more closely, since one of the bars drawn at 450 deg. F. withstood nearly 8,000,000 repetitions. They also remark that it is very hard to get test pieces from a 1,700 quench free from a multitude of finest hardening cracks.

A complete study of their results from all angles appears to show that the maximum fatigue strength of this steel varies both with the quenching and with the drawing temperature. Apparently the sample has the best resistance when it has been quenched from just above Ac_{cm}, which obliterates the previous grain structure. They also found that bars hardened from this temperature showed the highest strength after drawing to a structure of troostite. A final important conclusion of the authors is that re-shaped springs fail very quickly; in other words, a duplication of regular heat treatment on springs that have been used for some time actually hastens fatigue failure.
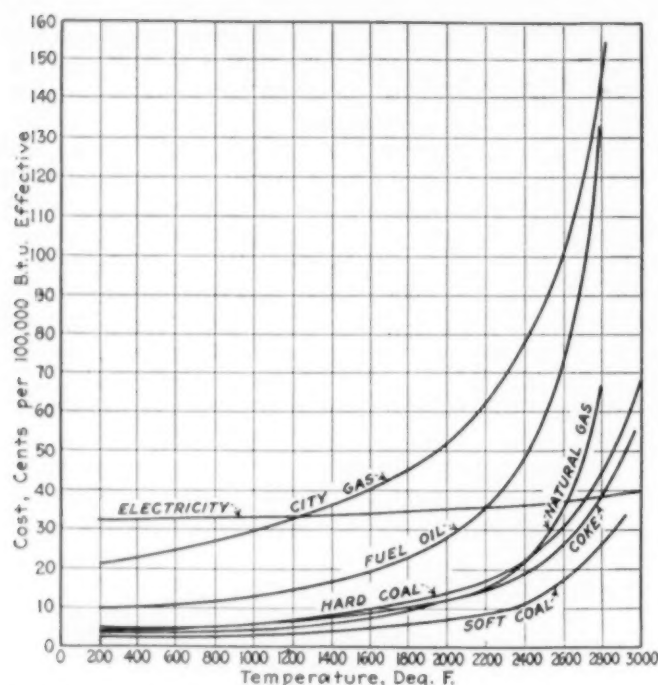
FIG. 2. COST OF MAINTAINING FURNACES AT VARIOUS
TEMPERATURES AND WITH DIFFERENT FUELS

Economy in Electric Furnaces

E. F. Collins, of the General Electric Co., presented
a paper on "Relative Thermal Economy of Electric and
Fuel-Fired Furnaces," containing the diagram repro-
duced in Fig. 2. This was plotted from data figured
for perfect combustion with 50 per cent excess air, and
regards nothing except cost of heat units involved.

DATA FOR CURVES

Points Figured Deg. F.	Suitable for	Radiation Loss per Cent
400	Baking	15
1600	Heat treating	20
2300	Forging	30
2800	Melting	40

Source of Heat	Calorific Value	Rate
Coke	13,000 B.t.u. per lb.	$10.00 per ton
Electricity	3,415 B.t.u. per kw.-hr.	9.81 per kw.-hr.
City gas	5.93 B.t.u. per cu.ft.	1.00 per M.
Fuel oil	19,000 B.t.u. per lb.	.10 per gal.
Anthracite	12,000 B.t.u. per lb.	10.00 per ton
Bituminous	12,550 B.t.u. per lb.	5.00 per ton
Natural gas	1,100 B.t.u. per cu.ft.	.30 per M.

As a matter of fact, electric power is actually cheaper
per B.t.u. at higher temperature, although convenience,
ease in handling, automatic regulation, low repairs and
overhead have favored electric heating even at low tem-
peratures. Metallic resistor furnaces are therefore
very popular in enameling ovens, core-baking ovens,
drying and annealing furnaces and hardening furnaces.
Arc, induction, or carbon resistor furnaces are also
widely applied to forging and melting furnaces; in
large installations their relative economy in cost of
heat is less than inferred from the curves owing to the
possibility of regenerating heat lost from carbon-fired
furnaces in products of combustion.

Determining Comparative Efficiency of Combinations of Alloys in Steel

"A Suggested Method for Determining the Compar-
ative Efficiency of Certain Combinations of Alloys in
Steel" was given by J. D. Cutter, metallurgist for the
Climax Molybdenum Co. His thesis is that if some
value be assigned to the effect of a certain alloy addi-
tion (merit index), and this value be divided by the
cost of the additions, then the quotient will be a figure
which represents relatively the comparative value of the
combination under discussion. Merit index should be
proportional to the ability of steel to withstand work
done upon unit quantity—i.e.,

$$merit\ index \propto work \div mass$$

Work done to break a standard tension test piece
is equal to the average pull times the distance it
works through, the latter factor being of course the
elongation. Lacking the complete stress-strain curve
for integrations, the author assumes the average of
elastic limit and the ultimate strength to be the average
pull. That is to say, his expression proportional to the
work is $\frac{1}{2}$ (e.l. + ult.) elongation. Furthermore, since
a piece which suffers pronounced necking usually has
the deformation strictly localized, while a piece which
breaks with little necking is ordinarily stretched
throughout its entire length, the mass of deformed
material is roughly proportional to 100 — reduction.
Hence, Mr. Cutter proposes the formula

$$Efficiency = \frac{merit\ index}{expenditure}$$
$$= \frac{\frac{1}{2}(e.l. + ult.) \times elonga.}{100 - red}$$
$$\div (lb.\ ferro \times unit\ cost)$$

which may be utilized to determine the relative econ-
omy of two alloys which might be used for the same
purpose.

Electrical Heat Treatment of Steel

H. P. MacDonald, vice-president, Sneed & Co., in
his paper, entitled "Electrical Heat Treatment of Steel,"
described an electrical resistance method he has been
using to heat-treat long rods and tubes, particularly
thin-walled nickel-steel tubing for lances and airplanes.
When using fuel-fired furnaces soaking is necessary
to insure uniform heating, and the tendency is toward
too long a soaking time with its attendant surface
deterioration and crystalline growth. Non-uniform
heating is also a prime cause of warping. To obviate
these difficulties the author has rigged up a pair of
grips to clasp the ends of the pipe or bar to be treated,
held vertically between them. A heavy current is
thrown through the piece, using the grips as contact
pieces, very much after the action of an electric butt
welder. As the pipe or bar heats it expands, and this
elongation is indicated by a pointer, whose movement is
geared to the upper grip. When passing through the
transformation the combination of volume change and
heat absorption halts the movement of the pointer, and
even reverses its motion; when finally transformed
the pointer again resumes its movement. Shortly there-
after both grips are released, interrupting the electric
current and dropping the bar into a vertical quench-
ing tank immediately below. Obviously, quenching of
pipe might be done while still in the grips by an
internal stream of oil or water. About $1\frac{1}{2}$ in. is unhard-
ened and wasted, where the copper grips were in con-
tact with the piece. Pieces may also be annealed in
the same machine by a simple modification in the
procedure. The method is rapid—requiring only a
minute to heat each piece; it obviates scale formation,
decarbonization, crystallization and warping; it is self-
indicating; and finally it is cheap, due to the efficient
application of the energy. On the other hand, it is
limited to straight pieces of uniform cross-section.

Recent Chemical & Metallurgical Patents

British Patents

Copper and Its Alloys.—For deoxidizing and refining copper and its alloys, a copper cartridge containing potassium phosphide is first added to the metal heated above its melting point to convert the impurities, silicon, arsenic and protoxide of copper into phosphorus compounds; then, at a higher temperature, a second copper cartridge, containing one of the metals of the alkaline earths or lithium, is added for the purpose of decomposing the phosphorus compounds, which burn at the expense of the alkaline-earth metal, and the oxides formed float on the surface of the copper. (Br. Pat. 142,441—1919. A. STRASSER, Rorschach, Switzerland, July 7, 1920.)

Glucose, Furfurol, Methyl Alcohol.—In the manufacture of furfurol, methyl alcohol and easily fermentable glucose from materials containing cellulose, a larger yield is obtained by the addition of a small quantity of an acid or acids besides the acid required for the conversion purpose. Hydrochloric, sulphuric, sulphurous and hydrofluoric acids are suitable, or acid salts, or salts decomposed by excess of acid or hydrolytically—e.g., chlorides of magnesium, calcium, aluminum, zinc and manganese. When several additional acids are used, excess of one ingredient is preferable. When hydrochloric acid is employed as the conversion agent, a mixture of sulphuric and sulphurous acids is preferred as catalyst. The ligneous material is mixed with one-half to less than an equal volume of water in order to prevent formation of non-fermentable sugars. After the vapors from a preliminary steam-treatment in an autoclave have been removed, the requisite acids are introduced, the conversion acid being added in sufficient quantity to leave the treated material so that it can readily be disintegrated, and the pressure is raised to 7 or 8 atmospheres. Steam may be employed at lower pressure by the addition of special "protective" substances—e.g., metallic oxides. On completion of the conversion process, the contents are rapidly cooled by evacuation into a cooling-chamber, where the furfurol is condensed. Any furfurol or methyl alcohol remaining in the residues is removed by suction or by blowing in steam. The sugar solution is obtained from the residue by lixiviation. (Br. Pat. 142,480—1919. A. CLASSEN, Aachen, Germany, July 7, 1920.)

Ammonia.—In making mixtures of hydrogen and nitrogen for preparing ammonia by the Haber process, a mixture of air, oxygen and steam, or of air and steam is passed through coke in a gas-producer heated to 650-850 deg. C. at a rapid rate to avoid formation of much carbon monoxide. The resulting gas is treated to remove sulphur compounds, oxygen, water, etc., and to transform carbon monoxide to carbon dioxide, which is removed by treatment with ammonia. If necessary, hydrogen may be added to bring the mixture to the requisite composition. The coke is prepared by carbonizing coal which has been washed to remove iron pyrites

and mixed iron oxide and calcium carbonate or other sulphur retainer, in a preliminary producer A. Air is introduced through openings D, and the gas withdrawn at E is purified and used for heating and power purposes. The hot coke is fed into the main producer B formed of a casing of sheet iron with a lining of hollow glazed bricks of silica in which passages are formed for preheating the gases. Owing to the low temperatures used and the rapid current of gas, the ash does not clinker, and much of it is carried by the gas into a separate settling-chamber (not shown). The hot gases are passed over limestone, magnesia, or magnesium limestone in a vessel K heated to about 700 deg. C. to remove sulphur compounds, are treated to remove dust and tar, and mixed with steam and passed over suitable known catalysts, such as iron oxide at about 450 deg. C. to convert carbon monoxide into carbon dioxide with formation of hydrogen, and to convert carbon bisulphide
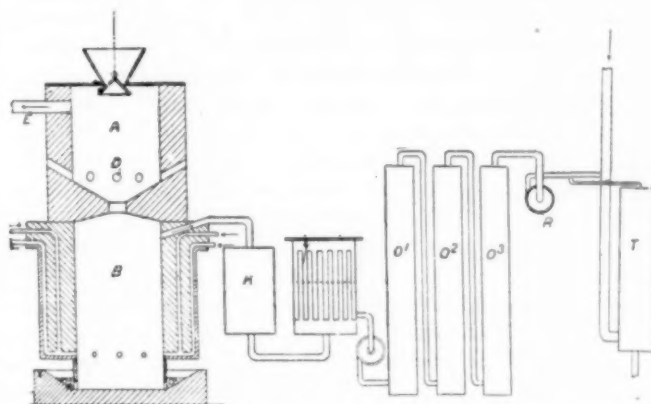
PRODUCER FOR NITROGEN-HYDROGEN MIXTURES

into sulphuretted hydrogen, which is removed by passage over iron oxide or by other means. The gases are mixed with air and passed over a low-temperature catalyst as described in Specification 127,609, to transform the residual carbon monoxide into carbon dioxide, and are compressed to 5-15 atmospheres to separate water, which is passed through a heat-exchanger and formed into steam at ordinary pressure and used in the earlier part of the process. Carbon dioxide is removed by treating the gases in towers O^1, O^2 with water and ammonia from the Haber plant or from another source. The ammonium bicarbonate formed is treated with sodium chloride to form sodium bicarbonate, or is passed over calcium sulphate to form ammonium sulphate. The towers may contain calcium sulphate to form ammonium sulphate directly. The gases are passed through a tower O^3 containing packing, water, and iron or copper to remove oxygen, and are compressed at R to 100-150 atmospheres. The water which separates is used to wash, in the tower T, the circulating gases in the Haber plants to remove the last traces of ammonia. The gases are mixed with the circulating gases, washed with water, and dried by passage through caustic soda or potash solution and over solid caustic potash or sodium wire. The final trace of carbon monoxide may be removed by adding oxygen and passing over a low-temperature catalyst as described in the above-mentioned specification, the carbon dioxide formed being removed by adding the gases to the catalyzed gases under pressure before removal of ammonia. (Br. Pat. 142,874—1919. J. HARGER, Liverpool, July 14, 1920.)

Current Events
in the Chemical and Metallurgical Industries

C.W.S. Officers Appointed

Results of the examinations for commissions in the Regular Army are now being announced. The following appointments as commissioned officers in the Chemical Warfare Service have been announced:

To be Majors, B. A. Brackenbury, San Francisco; A. M. Heritage, Washington, D. C.; H. H. Stickney, Jr., Lakehurst, N. J.

To be Captains: E. B. Blanchard, Charleston, S. C.; James H. Bogart, Boston; D. B. Bradner, Edgewood, Md.; Arthur Cobb, Lakehurst, N. J.; Harold Guiteras, Tyrone, N. M.; Stroud Jordan, Brooklyn; Lewis Latimer, Washington, D. C.; L. M. McBride, Chicago, Ill.; John G. McCoy, Edgewood, Md.; John A. MacLaughlin, Washington, D. C.; Earl Poppe, Fort Sam Houston, Tex.; Harry Scarborough, Cornwall-on-Hudson, N. Y.; Edward C. Tompson, Edgewood, Md.; William W. Wise, Camp Benning, Ga.; O. E. Roberts, Jr., Washington, D. C.; Edward Wolesensky, Cliffside, N. J.; Chester M. Scott, Edgewood, Md.

To be First Lieutenants: Joseph F. Battley, Edgewood, Md.; H. B. Bramlet, Camp Funston, Kan.; Guy L. Chamberlin, Lakehurst, N. J.; Patrick F. Craig, Lakehurst, N. J.; L. A. Elliott, Edgewood, Md.; Edwin L. Frederick, Catonsville, Md.; Arthur J. L. Hutchinson, Taft, Cal.; Harry A. Kuhn, Edgewood, Md.; Harry R. Lebkicker, Lakehurst, N. J.; George A. Mackay, Edgewood, Md.; Paul G. Miller, Alton, Ill.; David P. Miles, Redding, Cal.; Charles S. Moyer, Governor's Island, N. Y.; John E. Ott, Ocean View, Va.; Murray C. Wilson, Chicago; Howard Stokes, Lakewood, N. J.

To be Second Lieutenants: Fred M. Henley, Edgewood, Md.; Maurice E. Jennings, Seymour, Ind.; Harold A. Pelton, Camp Lewis, Washington; Paul R. Smith, Edgewood, Md.; M. E. Webber, St. Louis; Frank B. Gorin, Chicago; Shelby N. Griffith, Camp Dix; Ralph H. Tate, Owosso, Mich.

Further appointments are to be announced, but General Fries has been advised of the total number which have passed, which leaves thirty vacancies still to be filled. Additional examinations will be held.

Chemical Advisory Committee Named

General Amos A. Fries, head of the Chemical Warfare Service, states that he expects to lean heavily upon the committee of the American Chemical Society which is to co-operate with the Chemical Warfare Service in an advisory capacity. Charles H. Herty, who is to be chairman of the committee, has conferred at length with General Fries as to the assistance which the committee will be expected to give. The committee is to be divided into four sections. One is to be composed of research advisers, another of development advisers, a third of production advisers and a fourth physiological investigation advisers. The following personnel for these groups has been recommended:

Research advisers—W. D. Bancroft, Cornell University; R. C. Tolman, Fixed Nitrogen Research Laboratories, Washington, D. C.; A. B. Lamb, Harvard University; E. P. Kohler, Harvard University.

Development advisers—F. M. Dorsey, National Lamp Works, Cleveland; W. K. Lewis, Massachusetts Institute of Technology; L. T. Sutherland, New York.

Production advisers—L. C. Jones, National Aniline Co.; C. L. Reese, E. L. du Pont de Nemours & Co.; William H. Walker, Massachusetts Institute of Technology; Bradley Dewey.

Physiological investigation advisers—Reid Hunt, Harvard University; A. S. Loevenhart, University of Wisconsin; Julius Stieglitz, University of Chicago.

Nebraska Potash Situation Improves

Cessation of rains in Nebraska during recent weeks has greatly improved the potash situation at the evaporation plants in that state. The abnormal amount of rain earlier in the year had flooded the entire country and had so diluted the brine that evaporation costs were very high. A much larger recovery is being obtained from the same amount of fuel.

Despite rumors to the contrary, no plant in the Nebraska district has been closed, it is stated at the office of the United States Potash Producers' Association in Washington.

A recent report from France to that organization is to the effect that car shortage, strikes and the uncertainties pending the probable nationalization of the Alsatian mines makes it improbable that there will be any exports of Alsatian potash in the near future. As a matter of fact, delivery has not been completed on orders taken in the United States a year ago. It is not expected that the Alsatian production will offer any particular competition to Germany for a long time to some.

News of Alpha Chi Sigma

L. I. Shaw has resigned as national secretary and treasurer of the Alpha Chi Sigma fraternity. He is to be succeeded by B. H. Ball of Highland Park, Ill. Mr. Shaw has been appointed to succeed the late E. U. Titus as vice-president of the fraternity.

Mr. Shaw has held the office of secretary and treasurer since 1912. During that time he has seen the membership of the fraternity increase from 700 to 3,500. When he began his work as secretary there were seventeen chapters. The fraternity has expanded until it has become truly a national organization with thirty-one chapters. A chapter is now in existence at practically all the leading universities in the country.

The *Hexagon*, the official publication of the Alpha Chi Sigma fraternity, is to be published monthly in the future. Heretofore it has been appearing quarterly. Paul D. V. Manning, who recently succeeded R. S. McBride as editor of the *Hexagon*, will continue in charge of the paper.

Method for the Quantitative Measurement of Consistency

Some time ago the U. S. Bureau of Standards developed a method for the quantitative measurement of plasticity. This was described in Scientific Paper 278, and proved of great commercial value. Papers on the application of the method to paints have appeared in the *Proceedings* of the American Society for Testing Materials in 1919 and 1920.

The general method is to force the substance under investigation through a capillary tube by means of air pressure. The pressure is kept constant during any one run, but runs are made at various pressures with the same substance. The two values which are deduced from the readings thus obtained determine the consistency, but do not determine the plasticity as defined for mortars and plasters. In this latter sense, as described in Technologic Paper 169, plasticity depends upon other factors besides consistency.

At the present time an investigation is in progress at the Bureau in regard to the application of the plastometer, as used for paints, to adhesives such as starches and dextrines. This work is being done by an industrial associate under the general direction of a member of the Bureau's staff. The indications are that the quantitative measurement of the consistency of adhesives of definite concentration will do much to enable manufacturers to predict the exact behavior of their products in service.

Pulp and Paper Developments in Newfoundland

Grants to a British and a Norwegian pulp and paper company at the last session of the Colonial Legislature are indicative of important developments in the pulpwood timber resources of Newfoundland. Reports from St. John's, N. F., state that the British concern will locate its plant half way up the west coast at Bonne Bay, where there are large tracts of spruce and fir together with ample water facilities for power and transportation. The Norwegian company's site will be at Bonavista Bay, on the east coast.

At present the only pulp and paper mills on the island are at Grand Falls, established by the Anglo-Newfoundland Development Co. some years ago to supply the Northcliffe papers in England.

Negotiations are under way to exploit large tracts of spruce on the south coast. The extensive timber holdings of the Reid Newfoundland Co. are also expected to be utilized for pulp making in the near future. Another project contemplated is the establishment of paper and pulp mills, sawmills and veneer mills for the manufacture of birch into boxes and barrels at St. George's, on the west coast.

Philippine Vegetable Oil Companies Combine

It is reported by the San Francisco *Journal of Commerce* that the Philippine properties of the Visayan Refining Co., the Rizal Refining Co. and the Philippine Refining Co. have been consolidated into one company to be known as the Philippine Refining Corporation, with a capital of 20,000,000 pesos. Lever Bros. are large subscribers for the stock of the new corporation and Lord Leverhulme will be chairman of the board of directors. Lever Bros. are the largest consumers of coconut oil in the world and will monopolize practically the entire output of the consolidated company.

Anaconda to Manufacture Fertilizer

The Anaconda Copper Co. has decided to embark, with a plant of considerable size, in the manufacture of a super-phosphate fertilizer. It is the intention to market this fertilizer in the Middle West. A. E. Wells has just completed a survey of the markets for this type of fertilizer and is of the opinion that an outlet can be found for it throughout the farming regions of the upper Mississippi Valley.

Waste gases will be used for the manufacture of sulphuric acid. The phosphate rock will be obtained in Idaho and Montana. It is an intention of the Anaconda company to prepare a fertilizer which will contain 48 per cent of available phosphoric acid. In this way, it is believed, it will be possible to overcome the high transportation charge so as to enable the product to compete with the ordinary Eastern-made material which contains 16 per cent of available phosphoric acid.

Use of Etched Balls in the Brinell Test of Hardened Steels

At the request of the chairman of the Hardness Committee of the National Research Council, the device described by Hulgren for obtaining impressions with etched balls in the Brinell hardness test was examined in detail by the U. S. Bureau of Standards. Briefly this method of testing consists in etching the steel ball with which the impression is made for a minute or so in a weak (2 per cent) alcoholic-nitric acid solution, after which the test is performed as usual. It the specimen the hardness of which is to be determined is in a polished state, the impressions with the etched balls are very distinct, while those with an unetched ball are almost invisible when viewed at certain angles. If the specimen to be tested is not polished, however, preliminary etching of the ball does not appear to be of much advantage.

Wood Alcohol Causes Death of Nine Men

There was no admixture of poison gas with the alcohol which caused the death of nine employees of Edgewood Arsenal. General Amos A. Fries, head of the Chemical Warfare Service, investigated the matter personally immediately after the case was reported. General Fries found that some liquor had been secured off the arsenal grounds. The men who brought in the intoxicants gave a "party" to a number of their fellow-workers. The liquor soon ran out and to meet the demand for additional supplies resort was had to a steel drum of wood alcohol in one of the laboratories. Nine men drank the wood alcohol with fatal results.

The Problem of Scientific Abstracts

The Royal Society of London has called a conference in London beginning Sept. 28 to consider the future of the International Catalogue of Scientific Literature. Financial problems confront this publication and it is uncertain what further steps are necessary for its continuance or modification. American representatives will speak for the National Research Council, the Smithsonian Institution and the National Academy of Sciences. R. M. Yerkes and S. I. Franz will represent the Research Council; L. E. Dickson, professor of mathematics, University of Chicago, will represent the National Academy of Sciences; and L. C. Gunnell will represent the Smithsonian Institution.

Permeability of Concrete

Some preliminary tests have been made by the U. S. Bureau of Standards of a new apparatus for determining the rate of penetration of water through concrete and other permeable materials. The apparatus is so constructed that it is not necessary to mold the test piece in any particular shape, but any slab having one fairly smooth face may be tested. Only a few seconds are required for placing and adjusting the test specimen. This will permit specimens to be cut from walls or other portions of structures for tests. Tests so far made, while more in the nature of a try-out of the apparatus than the materials used, have furnished some rather interesting results.

In the following table the results of tests on samples of building stones from various quarries, as well as on some mortar and concrete specimens, are shown. The specimens varied from $1\frac{1}{4}$ in. to $2\frac{1}{2}$ in. in thickness and 60-lb. water pressure was applied over an area of 25 square inches.

Test Specimen	Absorption, in 24-Hr., per Cent	Thickness, In.	Time Required for Penetration Through Wall
Limestone 50	5.80	$1\frac{1}{4}$	$10\frac{1}{2}$ min.
Limestone 7E	3.10	$1\frac{3}{16}$	11 min.
Limestone 8907	4.40	$1\frac{1}{4}$	19 min.
Limestone 9c	4.60	$1\frac{1}{2}$	$2\frac{3}{4}$ min.
Limestone 14F	3.81	$1\frac{1}{4}$	20 sec.
Limestone 5G	3.48	$1\frac{1}{2}$	$1\frac{1}{4}$ min.
Sandstone	5.56	$2\frac{1}{2}$	10 sec.
1:6 portland cement mortar	7.8	2	$3\frac{1}{2}$ hr.
1:1½:2 concrete	5.8	2	Did not fail in 24 hr. When broken through water had penetrated only ½ in.

These results appear to bear out conclusions previously drawn in the Bureau's investigation of the durability of concrete in alkali soils that there is no apparent relation between absorption and permeability.

While considerable work must be done to standardize the method of making the permeability tests, it appears that this apparatus will assist in studying with a minimum of effort an important characteristic of concretes which has in the past been generally ignored, due to lack of suitable apparatus.

The Artificial Silk Industry

The end of June, 1920, saw the entry of the United States on a notable scale in artificial silk manufacture. The scarcity of the natural product and the increased demand for the artificial product have created a new industry.

As artificial silk was first invented and developed in the chemical laboratories abroad, Europe naturally took the lead in its production. In 1911, when artificial silk and its manufactures were first shown as a separate class on the import schedule, out of 1,947,423 lb. valued at $3,279,559 all but 12 lb. came from Europe. England was the chief shipper, followed by Germany, Austria-Hungary, Belgium, France and Switzerland.

The war greatly reduced the European production of artificial silk, stopping work in all the plants in Belgium and the invaded portion of France, while the shortage of labor and chemicals affected the industry in other countries. The great Tubize Co. in Belgium, in operation since 1900, with a pre-war production of about 10,000 lb. daily, dismantled its factories and buried or otherwise concealed its lead, copper and other metal fixtures, its electric motors, generators, wiring and belting, and escaped German confiscation. Shortly after the war closed, this factory was operating at the rate

of its pre-war output, and showed a profit for the fiscal year of 1919 of 4,178,264 fr. This plant uses the Chardonnet process and is about to commence making silk by the viscose process. Recently it contracted with an American syndicate to erect a large artificial silk factory in the United States with an initial capital of $5,000,000.

Artificial silk exports from the United States were not shown separately in the report schedule prior to the fiscal year 1917. In that year $857,318 worth of American-made products were distributed to all parts of the world. Europe received $395,990 of this amount, North America $260,216, South America $56,653, Asia $19,033, Oceania $118,850 and Africa $6,576.

Prior to the war only the viscose process for making artificial silk had been used in the United States and before 1914 the bulk of the yarns used by American manufacturers was imported from Europe. In 1919 there were only two concerns in the United States actually producing artificial silk yarns on a commercial scale, one located at Marcus Hook, Pa., and one at Roanoke, Va. The latter is said to be producing 150,-000 to 200,000 lb. per week at the present time. The extraordinary demand for this product has led to the recent formation of other corporations with abundant capital to establish large factories. Each of these large concerns is said to be allied with the largest producers in France, England and Belgium.

There are three varieties of artificial silk entering into our imports, according to their origin. They are classified as cellulose silk, collodion silk, and glue or gelatine silk. The products of the various processes differ from one another and from the natural silk in chemical composition. The artificial silk excels the natural product in luster only. France succeeded in making artificial silk bags to hold powder and wove certain parts of gas masks used on the front during the war. A Lyons factory is now producing a product called silk cellulose to be used in the manufacture of velvets, jerseys, satins, draperies, linings and other goods. The artificial silk textiles are also used in upholstery and carpet manufacture. Serviceable imitation horsehair hats are made of artificial silk braids, and novelties of this material appear each season in the millinery trade.

Non-Ferrous Metallurgical Research

Thanks to facilities afforded by one or two leading manufacturers, the association formed in Birmingham, England, for carrying on research work in connection with the non-ferrous metals is now getting into practical work, says the *Engineer* (London) of July 23, 1920. A specially installed electric furnace has been placed at the disposal of Prof. Thomas Turner, of the university, for experimental work upon the casting of brass and copper ingots. The furnace, which is itself in the experimental stage, has been erected on the firm's premises, and tests are being made which, it is hoped, will solve problems that have long puzzled the brass-founders, particularly respecting ingot blow-holes. Another local firm has placed a laboratory at the disposal of the association for twelve months, and this concession is likely to prove of distinct aid to research. Though the association is now eighteen months old, it is practically unhoused. Research work can be delayed only at serious risk to the development of the industry's welfare.

British Cotton-Growing Research Association

The British Cotton-Growing Research Association has issued a report covering the first nine months of the work, of which a short abstract was lately published in *Science*. In order to co-ordinate the work of its various departments a property known as The Towers has been purchased for its headquarters in East Didsbury, near Manchester. Heads of the following departments either have been or are about to be appointed: Chemistry, physics, colloids, botany and technology. Dr. E. A. Oxley of Cambridge and Sheffield Universities has been named head of the department of physics; Dr. J. C. Withers has been appointed to direct the abstracting and indexing of technical information in the records bureau. It is said that information is so scattered that it will be some time before a comprehensive idea can be given of the work accomplished in the past.

The report adds that the chief aim will be to arrive at the principles or theory underlying the practice of the industry, leaving the application of the theory to those actively engaged in the industry. Applied research cannot, however, be entirely omitted, especially in respect of such matters as may be considered beyond the resources of individual firms.

In co-operation with the Empire Cotton-Growing Committee a joint committee has been appointed, with the immediate object of granting scholarships to graduate students, so as to secure a supply of trained men for the future. Three botanical research studentships have already been established. The total number of individual members of the association is 1,408. The income for the year, including £6,750 government grant, amounts to £17,150.

Canada's Paint Industry

More than $17,000,000 worth of paints and varnishes were manufactured in Canada during 1918, according to a report published recently from the Mining, Metallurgical and Chemical Division of the Dominion Bureau of Statistics. In the same time Canada imported more than $6,000,000 worth of paints, varnishes and materials used in the paint and varnish industry. Of this sum $1,000,000 was spent in gums, nearly $2,000,000 in white zinc and more than $1,000,000 in rosin. Forty-five establishments were operated during the year with an aggregate capital investment of $15,784,610.

The report gives detailed information regarding the numbers and compensation of the officers, superintendents, clerks and wage-earners according to classes, and also shows the quantities and values of materials used in the manufacture of the products, which are listed by quantities and values.

This report, one of a series of advance chapters dealing with the production of chemicals and allied products in Canada during the year 1918, is available for free distribution to those interested. Requests should be addressed to the Dominion Bureau of Statistics, Ottawa.

U. S. Bureau of Mines Establishes Experiment Station at Rolla, Mo.

The Mississippi Valley Experiment Station of the U. S. Bureau of Mines has been located at the Missouri School of Mines and Metallurgy, Rolla, Mo. A conference of operators of the Mississippi Valley section will be held in the Chamber of Commerce Building, St. Louis, Oct. 9, to discuss problems that should be considered by the new station.

Investigation of Combination of Aluminous and Siliceous Bond Clays Used in Making Crucibles

During the war the making of glass pots, crucibles and various other special refractories was seriously interfered with, owing to the lack of certain clays formerly imported from Germany, particularly plastic bond clay known as Gross Almerode. The Bureau of Standards conducted an investigation with the object of finding an American clay or combination of clays which could be used as a substitute for the German material. It was found that a mixture of three parts of Arkansas kaolin and one part of No. 4 Kentucky ball clay formed a satisfactory substitute for the Gross Almerode clay, and this combination was used extensively during the war. This investigation is now being extended and will soon be completed. Sixty small pots have been made and will be subjected to the corrosive action of various kinds of glasses. It has been found that when used with 50 per cent grog and Arkansas kaolin it has even a lower shrinkage and higher porosity than the German clay. These are very valuable properties for clays to be used in the making of glass-house refractories, and present indications are that this clay will be extremely important for this particular purpose.

Movement of Nitrate Through Panama Canal

The movement of nitrate of soda through the Panama Canal during July totaled 32,101 tons. Of that amount 14,801 tons was consigned to American ports. The remainder went to European ports.

Book Reviews

THE ORGANIZATION OF INDUSTRIAL SCIENTIFIC RESEARCH. By *C. E. Kenneth Mees, D. Sc.*, Director of the Research Laboratory of the Eastman Kodak Co., Rochester, N. Y. Pp., ix + 175; 10 figures. New York and London: McGraw-Hill Book Co., Inc., 1920. Price, $2.

This book is intended by its distinguished author as a contribution to the study of the best methods of organizing research work for industrial purposes and of the conditions under which such work should be conducted. It gives consideration to general principles, but, in addition, reflects throughout its nine chapters the effort of the author to be as definite in statement as the nature of the subject will allow. The following matters are discussed seriately: Types of research laboratories; co-operative laboratories; the position of the research laboratory in an industrial organization; the internal organization of industrial research laboratories; the staff of a research laboratory; the building and equipment of the laboratory; the direction of the work; and the design of a research laboratory for a specific industry. There is also a select bibliography, which is comprehensive and usefully valuable for reference.

The scope of the book and the method of presentment employed in its preparation are excellent, and both industrialists and scientific workers will find it interesting and informative. It is thought, however, that most of its readers will regret that the author has given such brief treatment to certain of the aspects of the subject, that no attention is accorded to the co-ordination of research, and that more space is not devoted to the systematic collection and distribution of scientific information, especially research findings. The book is intended principally for manufacturers who have had no occasion to consider in detail the planning and executive control of a research department; and while most manufacturers who will decide to read

it will be convinced in advance of the need for research in their specific industries, the author has passed by an opportunity to demonstrate in review the economic and social benefits of properly planned, well directed scientific inquiry, for the use of executives who may need this material for educational purposes.   W. A. HAMOR.

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PERSONNEL ADMINISTRATION; ITS PRINCIPLES AND PRACTICE. By *Ordway Tead* and *H. C. Metcalf.* 538 pp., index. New York: McGraw-Hill Book Co., 1920.

During the past half-century a complete change has come about in the viewpoint of industrial administration, a change so gradual that few people have any clear realization of its completeness. The change is further masked by the fact that it was theoretically unnecessary. What has happened is that actual practice has come to approximate the general principles of social relations which have long been publicly proclaimed. With the new viewpoint and practice has come a new literature; countless articles on how to prevent accidents by means physical and metaphysical, how to conserve health, how to prevent fatigue, how to do things with the least effort, how to pick the right man for the right job and how to make him satisfied with it after he has it, first began to trickle into periodical literature and then swelled to a flood that has led to the founding of journals primarily devoted to such matters. Some of this literature is the result of the application of trained minds to industrial and social problems, some of it is a hybrid of sentimentalism and half-baked social theories, and a modicum of it is little better than charlatanism run riot. There has been great need for the gathering together of what has appeared, the separation of the wheat from the chaff, and the presentation of that most worth while in orderly and systematic fashion so that the busy man (and busy man is almost a synonym for the worker in industrial fields nowadays) can easily acquire a grasp of the progress that has been made. This is what the authors have tried to do in their volume on personnel administration, and on the whole they have succeeded very well. Ten years from now, it is quite possible, their views will be regarded as somewhat conservative and old-fashioned; ten years ago they would have been regarded as dangerously radical and socialistic. In not a few quarters today the fact that the authors have ventured to quote at times from the *New Republic* will be taken as sufficient indication that they are not worthy of consideration by conservative business men.

The field of their task is defined by the authors as setting forth the principles and the best prevailing practice in the field of the administration of human relations in industry, and they take up *seriatim* the personnel department, employment methods, health and safety, education, research (job analysis, specifications, etc.), rewards, administrative correlation, and joint relations. In a book of this character it is not reasonable to expect anything new beyond the integration of material, much as writers in the *Literary Digest* collate a number of quotations into a complete story. In both cases the result is almost certain to be interesting and helpful; the only opportunity for criticism lies in the choice of material and the relative amount of space accorded to it. Thus the seven pages devoted to safety may be regarded by some as all too little for its importance, yet into that space the authors have compressed an admirable summary of the principal methods for accident prevention, and the economic pressure of workmen's compensation laws puts sufficient emphasis on such work in the average plant so its importance does not need to be stressed. The health of the workers is accorded twice as much space, fatigue being considered at some length, but with the usual defect of regarding it as chiefly a physiological problem, the mental factor being underestimated, though possibly the authors may have it in mind in suggesting the value of changing jobs. Much of the longer chapter on standards of physical working conditions is really a more extended discussion of the health of the worker, and accident prevention is again mentioned. The

section on education takes up the training of executives, foremen and workers and goes on to consider the company magazine from its educational and other aspects, which leads naturally to the arousing of interest in work, to which twenty-five pages are devoted. Transfer and promotion are taken up from their educational aspects but in their development lead naturally into the next division, which the authors have designated as research—an inclusive term intended to cover the analytical and statistical study of the measurable factors in personnel problems. In their consideration of job analyses and job specifications, measurement of turnover and labor audit the authors display a humanness of view that is refreshing in comparison with the coldly statistical attack of most practitioners of scientific management. The question of rewards, wage payment, plans and methods, and meeting the industrial risks, is covered in fifty pages, which is all too little in proportion to its importance to the worker, but this is a topic which it is hard to make interesting to anyone except the recipient of the reward. The treatment is, on the whole, good, though the authors seem to share in some degree the common fallacy that pay can largely be based on what it costs a man to live rather than on an adjustment of shares in the value of the joint product which will insure a proper balance of labor and capital supply in the conduct of industry. So much discussion has been devoted to wages in the history of industry and so little of real enlightenment has emerged that the authors are perhaps wise in being brief. From this point the book grows steadily more "advanced." The boards of directors are still few that would accept the organization chart shown on page 375, where the production manager and personnel administrator are shown as co-equal in plant administration, and a subsequent chapter on the business value of the collective bargain, impartial as it is, will be regarded by many as too sympathetic to the employee. The chapter on national industrial councils will be interesting and useful to the many people who have been unable to get any clear comprehension of what has been afoot in England in the past few years, even though they may be inclined to raise more objections than the authors do to the general adoption of the plan in America. An unusually full index adds much to the usefulness of this valuable and timely volume.   T. T. READ.

Personal

H. M. BOYLSTON, of Sauveur & Boylston, has accepted an appointment to the chair of metallurgy in the Case School of Applied Science, Cleveland, Ohio.

A. W. MANGUM has resigned as chemical supervisor of soap making in the Procter & Gamble Co. to accept a position in the chemical division of Lever Bros. Co., Cambridge, Mass.

PERRY N. MOORE has recently become associated with Parker C. McIlhiney, consulting engineer, of New York City.

KARL C. PARRISH, of Cartagena, Colombia, South America, a prominent engineer in the development of mining and business properties in that district, is in Chicago and other Western points on an extended business trip. Among other activities he is the representative in Colombia for Fairbanks, Morse & Co.

C. PRICE-GREEN, commissioner of the Canadian National Railways, spent the week at the Chemical Exposition in the interest of the development of Canadian resources.

Dr. S. P. SADTLER left this week for a trip to the West to make a study of the brine potash industry. He will be gone several months.

MARK L. SPERRY, president of the Scovill Manufacturing Co., Waterbury, Conn., who has been with the company fifty-eight years, has retired. Edward O. Goss, who has been general manager, succeeded Mr. Sperry.

Current Market Reports

The Iron and Steel Market

Pittsburgh, September 24, 1920.

The stagnation in the pig-iron, semi-finished steel and finished steel markets has grown more intense in the past week. The markets for prompt and forward deliveries are equally dull.

For the dullness in the markets for prompt material the much heavier deliveries of late, due to the loosening up in the rail transportation situation, are chiefly responsible. For the dullness in late deliveries, in forward buying, uncertainty as to the future of prices is chiefly responsible.

For four months, April to July inclusive, the steel mills were piling steel, semi-finished and finished, because they could not ship the entire product. At the present time the accumulations are not as much as one-third as heavy as at the maximum, and some observers assert that the stocks are practically all cleaned up. It is clear that the reduction in stocks at mills in the past few weeks has been at two or three or four times as rapid a rate as that by which the stocks were accumulated.

PRICE READJUSTMENTS

It is putting it delicately to say that the lightness of forward buying in pig-iron and steel products is due to uncertainty as to the future of prices. In the mind of the average buyer there seems really to be no uncertainty, but rather a conviction that prices are going to be lower. This does not mean, however, that prices of all steel producers are expected to be lower. There has been a wide range of prices. All the independents have had prices much above those of the Steel Corporation, but some much farther above than others. Nowhere in the trade is the opinion expressed that the Steel Corporation's prices are going to come down. The corporation itself certainly has no such expectation, for after adhering punctiliously to the Industrial Board price schedule of March 21, 1919, for seventeen months, last month the corporation made some slight advances, $5 per gross ton on wire rods to $57 and $5 per net ton on cold-rolled strip steel to 6.15c., while it adopted a new card of nail extras, increasing the cost of an average nail specification 15c. or 20c. a keg.

PRESSURE FOR DELIVERIES

In some lines there is still fairly heavy pressure for deliveries on old contracts, these lines including nails, tin plate, standard steel pipe, oil country goods, the smaller sizes of merchant bars, and sheets. The case of sheets is the most impressive, for the pressure in general exists despite the fact that a large proportion of the sheets due the automobile trade is the subject of suspension of deliveries or of direct cancellation, yet the other consumers want all the sheets that can be furnished.

In plates and structural shapes there is no pressure at all. There are fair deliveries of plates on old contracts. In shapes there is not much contract business on books. The monthly report of the Bridge Builders' and Structural Society shows August bookings of fabricated steel contracts to have represented 40 per cent of the shop fabricating capacity, against 50 per cent for July.

SEMI-FINISHED STEEL SOFTENING

Demand for sheet bars has been light in the past week. On account of light deliveries on old contracts the mills have considerable tonnage due them for fourth quarter and they show little disposition to make fresh contracts. Conversion contracts have been impossible except in isolated cases and thus buying of sheet bars by sheet consumers has largely been absent. Some transactions have occurred, however, and these have been at about $65 Pittsburgh, or $2.50 decline. In one or two instances the f.o.b. mill price was $62.50 on account of the necessity of equalizing freight with Pittsburgh.

In billets the mill quotation remains at $60, but this quotation is practically nominal. Attractive lots of billets are offered at second hand at about $58 Pittsburgh, but there is no demand even for these.

THE CASE OF PIG IRON

Nothing could be clearer than the showing made by pig iron that prices on the recent advance were carried up too far. In most districts pig iron is absolutely stagnant, while in none is there any healthy degree of activity. Deliveries are heavier, as merchant production has increased somewhat, while in addition there has been the movement of furnace stocks previously accumulated, when cars were in short supply. Consumption, on the other hand, shows a decreasing tendency in the case of not a few consumers and none seem to be increasing their melt. These conditions would naturally make for an easier market.

The plainest test, however, is secured by referring to Southern iron. The Birmingham producers were conservative and when their price got up to $42 Birmingham at the end of last April they did not advance farther. With foundry pig iron on a $50 level at valley and Cleveland furnaces, Southern iron can penetrate farther, even with the large freight rate advances of Aug. 26, than formerly. Yet the buying of Southern iron is very light, and thus Northern iron at $50 practically "stands no show."

The Chemical and Allied Industrial Markets

New York, September 24, 1920.

The continued depression in these markets is being attributed to several causes: The unsettled conditions that usually precede a Presidential election, the "waiting" attitude that many consumers have assumed, and a return to more normal and pre-war levels. The depression is felt not in any one particular line, but in all commodity markets, and for this reason tables have been prepared to show the trend.

It will be noticed, among the chemicals, that of the eight items listed four show declines, two have increased and two remain about the same. In the coal-tar bases and intermediates there are six lower prices, one unchanged and two decreases. There have been no increases lately among the naval stores, and prices have been steadily going down. As can be seen, there is a $5 difference in all grades of rosin between the two years.

CHEMICALS

	Today	Last Week	Last Month	Last Year
Hydrochloric acid, 20 deg..	$2.00 @ 2.50	$2.25 @ 3.00	$2.25 @ 3.00	$1.00 @ 1.50
Hydrofluoric acid, 52 per cent..	.15 @ .16	.15 @ .16	.13½@ .14½	.10 @ .11
Bleaching powder	7.25 @ 7.50	7.00 @ 7.25	6.50 @ 7.50	1.75 @ 1.80
Phosgene........	1.25 @ 1.50	1.25 @ 1.50	.80 @ 1.05	.75
Soda ash, light..	2.80 @ 3.00	3.20 @ 3.50	3.20 @ 3.50	1.85 @ 1.90
Soda ash, dense..	3.25 @ 3.50	3.55 @ 3.65	3.55 @ 3.65	2.25 @ 2.50
Caustic soda....	4.25 @ 4.50	5.60 @ 5.70	5.60 @ 5.70	2.75 @ 3.00
Sodium prussiate, yellow.........	.25 @ .27	.23 @ .27	.23 @ .27	.18 @ .18½

COAL-TAR PRODUCTS

	Today	Last Week	Last Month	Last Year
Alpha- naphthol, crude.........	$1.30 @ 1.40	$1.35 @ 1.45	$1.40 @ 1.50	$1.00 @ 1.10
Benzene, pure water white....	.35 @ .40½	.38 @ .40½	.38 @ .40½	.24 @ .28
Cresylic acid, 97-99 per cent...	1.10 @ 1.15	1.15 @ 1.20	1.15 @ 1.20	.85 @ .90
Dichlorbenzene..	.07 @ .10	.07 @ .10	.08 @ .10	.07 @ .10
Dimethylaniline..	.90 @ 1.00	.95 @ 1.05	1.00 @ 1.05	.52 @ .57
Naphthalene, flake...........	.16 @ .17	.16 @ .17	.19 @ .21	.06½@ .07½
Orthotoluidine...	.35 @ .38	.30 @ .35	.30 @ .35	.30 @ .45
Solvent naphtha, water white.....	.20 @ .25	.23 @ .26	.33 @ .35½	.22 @ .27
Salicylic acid, tech...........	.45 @ .50	.50 @ .52	.50 @ .52	.30 @ .40

CRUDE RUBBER

	Today	Last Week	Last Month	Last Year
Para-Up-river fine	$0.27 @0.28	$0.29 @0.31	$0.32½@0.34	$0.54 @0.55
Up-river coarse	.18 @ .19	.19 @ .20	.20½@ .22	.31 @ .31½
Up-river caucho ball..	.18½@ .19½	.20 @ .22	.21 @ .21½	.31 @ .31½
Plantation—First latex crepe.....	$0.25	$0.30	$0.33	.41 @ .41½
Ribbed smoked sheets........	.23½	.28	.29½	.40 @ .40½
Brown, crepe, thin, clean...	.22½	.26	.27	.34 @ .36

NAVAL STORES

	Today	Last Week	Last Month	Last Year
Rosin B-D.......	$13.00	$14.00	$14.00@16.25	$18.00@18.25
Rosin E-I.......	13.10	14.50	16.60@16.75	18.50@20.50
Rosin W.L.-WW	12.50	15.00	17.25@17.50	23.50@25.50
Spirits of turpentine...........	1.45	1.49	1.60	1.75@ 1.80

OILS

	Today	Last Week	Last Month	Last Year
Corn oil, crude...	$0.12 @0.13	$0.11½@0.12	$0.14½@0.15½	$0.24 @0.25
Cottonseed oil, crude........	.10½@ .11	.10 @ .11	.10 @ .11	.21 @ .25
Linseed, raw, car lots.........	$1.22	$1.25	1.40 @1.43	2.20 @2.25
Palm, Niger....	.09½@ .10	.10 @ .10½	.11 @ .12	.16½@ .17½
Rapeseed, refined	1.30 @1.45	1.40 @1.50	1.40 @1.50	1.55 @1.60
Yellow bleached menhaden......	.87 @ .90	.90 @ .95	.95 @1.05	1.30 @1.37

The Baltimore Market

Baltimore, Md., September 23, 1920.

Buying activity on this market has not appreciably increased since the last writing. Because of the generally bearish situation, however, parcels of various raw materials are being quietly absorbed by the fertilizer manufacturers at lower prices than nominal quotations. It seems to be the general belief that the materials which have shown the most pronounced decline in prices have about reached the bottom.

Orders for bagged goods are coming in more rapidly and as a consequence the trade is feeling more optimistic than a few weeks ago for a good fall business. The demand, however, for mixed goods will probably show a curtailment, with the result that it will be necessary for some to carry over stocks of raw material until spring.

The local car situation has improved. It is estimated that shippers are now receiving about 75 per cent of their car requirements.

ACID PHOSPHATE

There has been no appreciable weakness in the market for this commodity. Spot parcels are changing hands at prices in line with last quotations of $20 per ton, bulk acid phosphate, run of pile, basis 16 per cent A. P. A., f.o.b. Baltimore. Also a few sales for export have been noted. Spain has been receiving a fair sized tonnage from this port.

NITRATE OF SODA

The market on nitrate is in a distinctly unsettled condition, with the general trend of the market downward.

Importers are quoting well above the actual market, though there is a report of one recent sale by an importer of a round lot of 95 per cent at $3.50 ex-vessel Atlantic port for November-December arrival. Spot parcels are being freely offered in the South as low as $3.50 and counter propositions are being solicited. Deliveries after Jan. 1 are held at higher figures.

SULPHATE OF AMMONIA AND CYANAMIDE

There has been but little change in chemical ammoniates. A few resale parcels of sulphate are being offered at $5.50 delivered in bulk with counter bids solicited. A sale of a round lot of cyanamide in bags has been reported at $4.50.

POTASH

The potash market is unchanged. Kainit and manure salts may be had under $2 and muriate is being quoted nominal at $2.25. A rise in this market is dependent upon a curtailment of shipments from the German and Alsatian deposits.

FISH SCRAP

Menhaden fish scrap has declined appreciably in price since the last report in this journal. The past week has brought local trading of several thousand tons at prices ranging from $7.50 per unit of ammonia to $6.50. This break was due largely to the tight money situation together with lack of storage space at the factories. It is thought that the entire accumulation of scrap on Chesapeake Bay has been cleaned up. It has also been noted that the market has begun to recover as a consequence.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride......................	lb.	—	$0.65 – $0.75
Acetone...........................	lb.	$0.15 –$0.20	.21 – .22
Acid, acetic, 28 per cent...............	cwt.	3.50 – 3.75	4.00 – 4.50
Acetic, 56 per cent..............	cwt.	6.50 – 7.50	8.50 – 9.50
Acetic, glacial, 99½ per cent, carboys..	cwt.	14.00 –16.00	16.25 – ....
Boric, crystals................	lb.	.15½ – .16	.16½ – .19
Boric, powder.................	lb.	.15½ – .16½	.17 – .20
Citric........................	lb.	.78 – .80	.82 – .84
Hydrochloric (nominal).........	cwt.	2.00 – 2.50	2.75 – 3.00
Hydrofluoric, 52 per cent (nominal).	lb.	.15 – .16	.16½ – .18
Lactic, 44 per cent tech.........	lb.	.10 – .11½	.12 – .1(
Lactic, 22 per cent tech.........	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P................	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)..			
Nitric, 40 deg.................	lb.	.06 – .07	.07½ – .08½
Nitric, 42 deg.................	lb.	.07½ – .08	.08½ – .09½
Oxalic, crystals...............	lb.	.45 – .50	.52 – .55
Phosphoric, Ortho, 50 per cent solution	lb.	.18 – .23	.24 – .25
Picric.......................	lb.	.28 – .35	.40 – .50
Pyrogallic, resublimed..........	lb.	2.30 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars.....	ton	12.00 –16.00	....—....
Sulphuric, 60 deg., drums.......	ton		
Sulphuric, 66 deg., tank cars.....	ton	16.00 –17.00	18.00 – 20.00
Sulphuric, 66 deg., drums.......	ton	26.00 –28.00	
Sulphuric, 66 deg., carboys......	ton	—....	
Sulphuric, fuming, 20 per cent (oleum) tank cars........	ton	27.00 –30.00	37.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) drums............	ton	28.00 –30.00	38.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys........	ton	32.00 –35.00	40.00 – ....
Tannic, U. S. P...............	lb.	1.45 – 1.50	1.55 – 1.65
Tannic (tech.)................	lb.	.60 – .70	.80 – .90
Tartaric, crystals.............	lb.	....—....	.74 – .77
Tungstic, per lb. of WO........	lb.	—....	1.20 – 1.40
Alcohol, Ethyl (nominal)........	gal.	5.50 – 5.75	6.00 – 7.00
Alcohol, Methyl (see methanol)			
Alcohol, denatured, 188 proof (nominal)	gal.	—....	1.12 – 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	—....	1.05 – 1.10
Alum, ammonia lump............	lb.	.05 – .05½	.05½ – .06
Alum, potash lump.............	lb.	.08½ – .08½	.09 – .09½
Alum, chrome lump.............	lb.	— .17	.18 – .19
Aluminum sulphate, commercial..	lb.	.04½ –	
Aluminum sulphate, iron free....	lb.	.06 –	
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.09½ – .10½	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.35 – .35½	.36 – .37
Ammonium carbonate, powder.....	lb.	.16 – .16½	.17 – .18
Ammonium chloride, granular (white salammoniac) (nominal).........	lb.	.15½ – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)........	lb.	.13 – .13½	.13½ – .14½
Ammonium nitrate.............	lb.	.09 – .10	.11 – .14
Ammonium sulphate............	lb.	.07 – .07½	.08½ –
Amylacetate..................	gal.	—....	5.00 –
Amylacetate tech..............	gal.	—....	4.75 – 5.25
Arsenic, oxide, lumps (white arsenic)..	lb.	.14 – .16	.16½ – .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.17 – .18	.19 – .23
Barium chloride...............	ton	130.00–150.00	
Barium dioxide (peroxide).......	lb.	.21 – .23	.24 – .25
Barium nitrate................	lb.	.10 – .12	.12½ – .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calcium hypochlorite)			
Blue vitriol (see copper sulphate)..		—....	—....
Borax (see sodium borate).......			
Brimstone (see sulphur, roll)......			
Bromine......................	lb.	.70 – .90	1.00 – 1.05
Calcium acetate...............	cwt.	3.50 – 3.55	
Calcium carbide...............	lb.	.04½ – .04½	.04½ – .05½
Calcium chloride, fused, lump.....	ton	33.00 –34.00	35.00 – 45.00
Calcium chloride, granulated......	lb.	.02 – .02½	.03 – .03½
Calcium hypochlorite(bleaching powder)	cwt.	7.25 – 7.50	8.00 – 8.50
Calcium peroxide..............	lb.	—....	1.50 – 1.70
Calcium phosphate, monobasic....	lb.		.75 – .80
Calcium sulphate, pure	lb.		.25 – .30
Carbon bisulphide.............	lb.	.08 – .09	.10 – .11
Carbon tetrachloride, drums......	lb.	.14 – .15	.16 – .17
Carbonyl chloride (phosgene)....	lb.	—....	1.25 – 1.50
Caustic potash (see potassium hydroxide)			
Caustic soda (see sodium hydroxide)			
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform...................	lb.	.40 – .43	.44 – .47
Cobalt oxide..................	lb.	—....	2.00 – 2.05
Copperas (see iron sulphate)......			
Copper carbonate, green precipitate.......	lb.	.27 – .28	.29 – .31
Copper cyanide...............	lb.	—....	.65 – .70
Copper sulphate, crystals........	lb.	.08 – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)			
Epsom salt (see magnesium sulphate)			
Ethyl Acetate Com. 85%......	gal.	1.10 – 1.30	1.40 –
Ethyl Acetate pure (acetic ether 98% to 100%)		—....	1.75 –
Formaldehyde, 40 per cent (nominal)	lb.	.48 – .50	
Fusel oil, ref.................	gal.	—....	5.25 – 6.00
Fusel oil, crude (nominal).......	gal.	—....	
Glauber's salt (see sodium sulphate)			
Glycerine, C. P. drums extra.....	lb.	—....	.26½ – .28½
Iodine, resublimed.............	lb.	4.30 – 4.35	4.40 – 4.45
Iron oxide, red...............	lb.	—....	.03 – .20
Iron sulphate (copperas).........	cwt.	2.00 – 2.25	2.35 – 2.75
Lead acetate, normal...........	lb.	—....	.13½ – .16
Lead arsenate (paste)..........	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals..........	lb.	—....	.90 – 1.00
Litharge.....................	lb.	.14 – .15	.15½ – .16
Lithium carbonate.............	lb.	—....	1.50 –
Magnesium carbonate, technical..	lb.	.12½ – .13½	.15 – .16
Magnesium sulphate, U. S. P.....	100 lb.	3.50 – 3.90	4.00 – 4.50
Magnesium sulphate, commercial..	100 lb.	—....	3.50 – 3.60
Methanol, 95%...............	gal.	—....	3.25 – 3.30
Methanol, pure...............	gal.	—....	3.50 – 4.50
Nickel salt, double............	lb.	—....	.14 – .16
Nickel salt, single............	lb.	—....	.13 – .14
Phosgene (see carbonyl chloride)			
Phosphorus, red...............	lb.	.50 – .55	.60 – .65
Phosphorus, yellow............	lb.	—....	.35 – .37
Potassium bichromate..........	lb.	.34 – .36	.39 – .40

		Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb.	$0.52 – $0.56	$0.57 – $0.58
Potassium bromide, granular	lb.	–	.70 – .73
Potassium carbonate, U. S. P.	lb.	.50 – .55	.56 – .60
Potassium carbonate, crude	lb.	.20 – .21	.23 – .25
Potassium chlorate, crystals	lb.	.18 – .18½	.19 – .20
Potassium hydroxide (caustic potash)	lb.	.27 – 28	.29 – .33
Potassium iodide	lb.	–	3.35 – 3.60
Potassium nitrate	lb.	.17 – .17½	.19 – .21
Potassium permanganate	lb.	.75 – 80	.85 – .95
Potassium prussiate, red	lb.	.85 – .95	1.00 – 1.05
Potassium prussiate, yellow	lb.	.32 – .36	.35 – .40
Potassium sulphate (powdered)	ton	$240.00 – 255.00	.....
Rochelle salts (see sodium potas. tartrate)		–	.....
Salammoniac (see ammonium chloride)		–	.....
Sal soda (see sodium carbonate)		–	.....
Salt cake	ton	–	48.00 – 50.00
Silver cyanide (nominal)	oz.	–	1.25 –
Silver nitrate (nominal)	oz.	–	.60 – .62
Soda ash, light	100 lb.	–	2.80 – 3.00
Soda ash, dense	100 lb.	–	3.25 – 3.50
Sodium acetate	lb.	.10 – .15	.20 – .25
Sodium bicarbonate	100 lb.	2.50 – 2.75	3.00 – 3.50
Sodium bichromate	lb.	.22 – .24	.26 – .27
Sodium bisulphate (nitre cake)	ton	7.00 – 8.00	9.00 – 11.00
Sodium bisulphite Powdered, U.S.P.	lb.	.08½ –	.10 – .11
Sodium borate (borax)	lb.	.09 – .10	.11 – .12
Sodium carbonate (sal soda)	100 lb.	2.00 – 2.10	2.15 – 2.25
Sodium chlorate	lb.	.11 – .12	.12½ – .14
Sodium cyanide, 96-98 per cent	lb.	.25 – .30	.32 – .35
Sodium fluoride	lb.	.18 –	.19 – .20
Sodium hydroxide (caustic soda)	100 lb.	5.60 – 5.70	5.75 – 6.00
Sodium hyposulphite	lb.	–	.03 – .04
Sodium molybdate	lb.	2.50 –	3.25½ –
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.16 – .18	.19 – .20
Sodium peroxide, powdered	lb.	.32 – .35	.35 – .40
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	–	.39 – .40
Sodium prussiate, yellow	lb.	.25 – .27	.31 – .32
Sodium silicate, solution (40 deg.)	lb.	.01¼ – .01½	.02 – .02¼
Sodium silicate, solution (60 deg.)	lb.	.02¼ – .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60 – 1.70	1.75 – 2.50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.09½ –	.10½ – .11
Sodium sulphite, crystals	lb.	.04 – 0.4½	.04½ – .05
Strontium nitrate, powdered	lb.	.15 – .18½	.19 – .20
Sulphur chloride red	lb.	.08 – .09	.10 – .10½
Sulphur, crude	ton	16.00 – 20.00	–
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	–	3.80 – 4.35
Sulphur, roll (brimstone)	100 lb.	–	3.40 – 3.90
Tin bichloride (stannous)	lb.	.42½ – .44	.45 – .46
Tin oxide	lb.	–	.55 – .65
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.13 – .13½	.13½ – .17
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13 – .14
Zinc oxide, U. S. P.	lb.	.17 – .25	.....
Zinc sulphate	lb.	.03½ – .03½	.04 – .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.30 –	$1.40
Alpha-naphthol, refined	lb.	1.50 –	1.65
Alpha-naphthylamine	lb.	.48 –	.52
Aniline oil, drums extra	lb.	.30 –	.33
Aniline salts	lb.	.35 –	.40
Anthracene, 80% in drums (100 lb.)	lb.	.90 –	1.00
Benzaldehyde (f.f.c.)	lb.	2.00 –	2.10
Benzidine, base	lb.	1.35 –	1.40
Benzidine sulphate	lb.	1.15 –	1.25
Benzoic acid, U.S.P.	lb.	.85 –	.90
Benzoate of soda, U.S.P.	lb.	.80 –	.90
Benzene, pure, water-white, in drums (100 gal.)	gal.	.35 –	.40½
Benzene, 90% in drums (100 gal.)	gal.	.33 –	.38½
Benzyl chloride, 95-97%, refined	lb.	.35 –	.40
Benzyl chloride, tech.	lb.	.25 –	.35
Beta-naphthol benzoate (nominal)	lb.	3 50 –	4.00
Beta-naphthol, sublimed (nominal)	lb.	.70 –	75
Beta-naphthol, tech (nominal)	lb.	.65 –	.70
Beta-naphthylamine, sublimed	lb.	2.25 –	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 –	.19
Ortho-cresol, in drums (100 lb.)	lb.	.23 –	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.10 –	1.15
Cresylic acid, 95-97%, dark, in drums	gal.	1.05 –	1.10
Cresylic acid, 50%, first quality, drums	gal.	.65 –	.75
Dichlorbenzene	lb.	.07 –	.10
Diethylaniline	lb.	1.50 –	1.60
Dimethylaniline	lb.	.90 –	1.00
Dinitrobenzene	lb.	.30 –	.37
Dinitrochlorbenzene	lb.	.32 –	.35
Dinitronaphthalene	lb.	.45 –	.55
Dinitrophenol	lb.	.40 –	.45
Dinitrotoluene	lb.	–	.40
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 –	.40
Diphenylamine (nominal)	lb.	.80 –	.85
H-acid (nominal)	lb.	1.90 –	2.05
Meta-phenylenediamine	lb.	1.25 –	1.30
Monochlorbenzene	lb.	.18 –	.20
Monoethylaniline	lb.	2.00 –	2.40
Naphthalene crushed, in bbls. (250 lb.)	lb.	... –	...
Naphthalene, flake	lb.	.16 –	.17
Naphthalene, balls	lb.	.16 –	.17
Naphthionic acid, crude	lb.	.75 –	.85
Nitrobenzene	lb.	.14 –	.19
Nitro-naphthalene	lb.	.40 –	.50
Nitro-toluene	lb.	.18 –	.25
Ortho-amidophenol	lb.	3.25 –	4.25
Ortho-dichlor-benzene	lb.	.15 –	.20
Ortho-nitro-phenol	lb.	.80 –	.85
Ortho-nitro-toluene	lb.	.25 –	.40
Ortho-toluidine	lb.	.35 –	.38
Para-amidophenol, base	lb.	2.50 –	3.00
Para-amidophenol, HCl.	lb.	2.50 –	3.00
Para-dichlorbenzene	lb.	.08 –	.12
Paranitroaniline	lb.	1.10 –	1.15

Para-nitrotoluene	lb.	1.25 –	1.40
Para-phenylenediamine	lb.	2.50 –	2.65
Para-toluidine	lb.	2.00 –	2.25
Phthalic anhydride	lb.	.60 –	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 –	20
Pyridine	gal.	2.00 –	3 50
Resorcinol, technical	lb.	4.25 –	4.50
Resorcinol, pure	lb.	6.25 –	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.45 –	.50
Salicylic acid, U. S. P.	lb.	.45 –	.50
Salol	lb.	.90 –	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.30 –	.35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.20 –	.26
Sulphanilic acid, crude	lb.	.32 –	.35
Tolidine	lb.	1.70 –	2.50
Toluidine, mixed	lb.	.45 –	.55
Toluene, in tank cars	gal.	.35 –	.....
Toluene, in drums	gal.	.38½ –	.40½
Xylidines, drums, 100 gal.	lb.	.50 –	.65
Xylene, pure, in drums	gal.	.47½ –	.50½
Xylene, pure, in tank cars	gal.	.45 –	.....
Xylene, commercial, in drums, 100 gal.	gal.	32½ –	.35½
Xylene, commercial, in tank cars	gal.	30 –	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36 –	$0.39
Beeswax, refined, light	lb.	.37 –	.38
Beeswax, white pure	lb.	.63 –	.68
Carnauba, No. 1. (nominal)	lb.	.90 –	.95
Carnauba, No. 2, regular (nominal)	lb.	.85 –	.86
Carnauba, No. 3, North Country	lb.	.35 –	.36
Japan	lb.	.17 –	.18
Montan, crude	lb.	.25 –	.26
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09 –	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09½ –	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11 –	.11½
Paraffine waxes, refined, 125 m.p	lb.	.12½ –	
Paraffine waxes, refined, 128-130 m.p.	lb.	.13 –	.15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16 –	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½ –	.18½
Stearic acid, single pressed	lb.	.20 –	.21
Stearic acid, double pressed	lb.	.22 –	.23
Stearic acid, triple pressed	lb.	.24 –	.25

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$2.15
Pine oil, pure, dest. dist.	gal.	1.80
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b. New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$13.00 –	
Rosin E-I	280 lb.	13.10 –	
Rosin K-N	280 lb.	13.15 –	
Rosin W. G.-W. W	280 lb.	13.25 –	
Wood rosin, bbl.	280 lb.	12.50 –	
Spirits of turpentine	gal.	1.45 –	
Wood turpentine, steam dist	gal.	–	
Wood turpentine, dest. dist.	gal.	–	
Pine tar pitch, bbl.	200 lb.	–	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	4.50 –	15.00
Retort tar, bbl.	500 lb.	5.00 –	15.50
Rosin oil, first run	gal.	.72 –	
Rosin oil, second run	gal.	.75 –	
Rosin oil, third run	gal.	.92 –	

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine	lb.	$0.27 –	$0.28
Upriver coarse	lb.	.18 –	.19
Upriver caucho ball	lb.	.18½ –	.19½
Plantation—First latex crepe	lb.	.25 –	
Ribbed smoked sheets	lb.	.23½ –	
Brown crepe, thin, clean	lb.	.22½ –	
Amber crepe No. 1	lb.	.22 –	

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.16½ –	$0.18
Castor oil, AA, in bbls.	lb.	.17 –	.17½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.17½ –	.18
Cocoanut oil, Ceylon grade, in bbls.	lb.	.15 –	.16
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.16 –	.17½
Corn oil, crude, in bbls.	lb.	.12 –	.13
Cottonseed oil, crude (f.o.b. mill)	lb.	.10½ –	.11
Cottonseed oil, summer yellow	lb.	.14 –	.15
Cottonseed oil, winter yellow	lb.	–	
Linseed oil, raw, car lots (domestic)	gal.	1.22 –	
Linseed oil, raw, tank cars (domestic)	gal.	1.16 –	
Linseed oil, boiled, car lots (domestic)	gal.	1.24 –	

Olive oil, commercial	gal.	3.00	—	3.50
Palm, Lagos	lb.	.10½	—	
Palm, bright red	lb.		—	
Palm, Niger	lb.	.09½	—	.10
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10½	—	.12½
Peanut oil, refined, in bbls	lb.	.17	—	.18
Rapeseed oil, refined in bbls	gal.	1.30	—	1.45
Rapeseed oil, blown, in bbls	gal.	1.60	—	1.70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.14	—	.14½
Soya bean oil, tank-cars, f.o.b., Pacific coast	lb.	.10	—	.11

FISH

Winter pressed Menhaden	gal.	$0.85	—	$0.90
Yellow bleached Menhaden	gal.	.87	—	.90
White bleached Menhaden	gal.	.90	—	.92
Blown Menhaden	gal.	1.05	—	....

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00	—	$25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18.00	—	20.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8.00	—	10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23.00	—	25.00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00	—	19.00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12.00	—	
Barytes, floated, f.o.b. St. Louis	net ton	26.50	—	28.00
Barytes, crude, min. 98% ba., Missouri	net ton	11.00	—	11.25
Blanc fixe, dry	lb.	.05½	—	.06
Blanc fixe, pulp	net ton	60.00	—	80.00½
Casein	lb.	.15	—	.18
Chalk, domestic, extra light	lb.	.05	—	.06
Chalk, domestic, light	lb.	.04½	—	.05½
Chalk, domestic, heavy	lb.	.04	—	.05
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.05	—	.06
Chalk, English, dense	lb.	.04½	—	.05
China clay (Kaolin) crude, f.o.b. mines, Georgia	net ton	9.00	—	12.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00	—	15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18.00	—	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00	—	40.00
China clay (Kaolin), imported, lump	net ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	net ton	30.00	—	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7.50	—	8.00
Feldspar, crude, f.o.b. Maine	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	30.00	—	35.00
Fuller's earth, granular, f.o.b. Fla	net ton	25.00	—	
Fuller's earth, powdered, f.o.b. Fla	net ton	18.00	—	
Fuller's earth, imported, powdered	net ton	35.00	—	40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.		—	.01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.		—	.02
Graphite, crucible, 80% carbon Ashland, Ala.	lb.		—	.05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.		—	.10
Graphite, crucible, 85% carbon	lb.		—	.08
Graphite, crucible, 88% carbon	lb.		—	.09½
Graphite, crucible, 90% carbon	lb.		—	.10½
Pumice stone, imported, lump	lb.	.04	—	.50
Pumice stone, domestic, lump	lb.	.06	—	
Pumice stone, ground	lb.	.04	—	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton		—	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton		—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton		—	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	—	7.50
Shellac, orange fine	lb.	1.35	—	1.40
Shellac, orange superfine	lb.	1.40	—	1.45
Shellac, A. C. garnet	lb.	1.10	—	1.15
Shellac, T. N	lb.	1.15	—	1.20
Soapstone	ton	15.00	—	25.00
Talc, paper-making grades, f.o.b. Vermont	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00	—	15.00
Talc, imported	ton	60.00	—	70.00
Talc California Talcum Powder grade	ton	20.00	—	35.00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots	net ton	100	—	110
Chrome brick, 9-in. strs. and sizes, f.o.b. Baltimore	net ton	100	—	105
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	55	—	60
Fire clay brick, 1st quality, f.o.b. St. Louis	1,000	45	—	
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75	—	
Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	50	—	55
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	110	—	120
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras		
Magnesite brick, f.o.b. Chester	net ton	90	—	100
Silica brick, 9-in. and 9-in. sizes, Chicago district	1,000	65	—	70
Silica brick, f.o.b. Birmingham	1,000	56	—	61
Silica brick, f.o.b. Mt. Union, Pa.	1,000	65	—	...

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.18	—	.19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20	—	.21
Ferro-manganese, 76-80% Mn, domestic	gross ton	195.00	—	200.00
Ferro-manganese, 76-80% Mn, English	gross ton	170.00	—	175.00
Spiegeleisen, 18-22% Mn	gross ton	80.00	—	85.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.25	—	2.75
Ferro-silicon, 10-15%	gross ton	60.00	—	65.00
Ferro-silicon, 50%	gross ton	80.00	—	90.00
Ferro-silicon, 75%	gross ton	150.00	—	160.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.10	—	1.15
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	—	
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	6.50	—	7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20% silica, not more than 14% moisture	gross ton	$10.00	—	$11.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60	—	.65
Chrome ore, 50%, max., Cr_2O_3, f.o.b. Atlantic Seaboard	unit	.65	—	.70
*Coke, foundry, f.o.b. ovens	net ton	18.00	—	20.00
*Coke, furnace, f.o.b. ovens	net ton	17.00	—	18.00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	—	
Fluor spar, lump, f.o.b.Tonuco, New Mexico	net ton	17.50	—	
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	25.00	—	27.50
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	—	85.02
Manganese Ore, 50% Mn, c i.f. Atlantic seaport	unit	.65	—	.75
Manganese ore, chemical (MnO_2)	gross ton	75.00	—	90.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y	lb.	.70	—	.75
Monazite, per unit of ThO_2	unit	42.00	—	
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	—	
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½	—	
Pyrites, Spanish, run of mines, ci.f., Atlantic seaport	unit	.12	—	.14
Pyrites, domestic, fines	unit	.12	—	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15	—	
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	6.00	—	
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	5.00	—	
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75	—	3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium Ore, per lb. of V_2O_3 contained	lb.	1.25	—	
Zircon, washed, iron free	lb.	.10	—	

*Nominal

Non-Ferrous Metals

New York Markets

		Cents per Lb.
Copper, electrolytic		18.50
Aluminum, 98 to 99 per cent		34.80
Antimony, wholesale lots, Chinese and Japanese		7.00@7.50
Nickel, ordinary (Ingot)		43.00
Nickel, electrolytic		45.00
Tin, 5-ton lots		45.50
Lead, New York, spot		8.40
Lead, E. St. Louis, spot		8.20
Zinc, spot, New York		8.00
Zinc, spot, E. St. Louis		7.70@8.05

OTHER METALS

Silver (Commercial)	oz.	$0.99½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	4.00@6.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	115.00
Iridium	oz.	350.00
Palladium	oz.	100.00@110.00
Mercury	75 lb.	83.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33.50
Copper bottoms	38.00
Copper rods	38.00@40.00
High brass wire and sheets	30.25
High brass rods	27.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	38.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	15.00	17.00	14.00	15.00
Copper, heavy and wire	14.00	16.00	13.50	14.50
Copper, light and bottoms	12.50	14.00	12.00	13.00
Lead, heavy	7.00	4.75	7.00	7.00
Lead, tea	5.00	3.75	4.00	6.00
Brass, heavy	9.50	10.50	10.00	14.50
Brass, light	7.00	7.50	7.00	8.00
No. 1 yellow brass turnings	8.50	10.00	7.50	8.00
Zinc	5.00	5.00	4.50	5.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York Current	One Month Ago	One Year Ago	Cleveland Current	One Year Ago	Chicago Current	One Year Ago
Structural shapes	$4.58	$4.47	$3.47	$5.00	$3.37	$4.08	$3.47
Soft steel bars	4.73	4.62	3.37	4.50	3.27	3.98	3.37
Soft steel bar shapes	4.73	4.62	3.37		3.27	3.98	3.37
Soft steel bands	6.43	6.32	4.07	6.25			
Plates, ¼ to 1 in. thick	4.78	4.67	3.67	4.50	3.57	4.28	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

SAN FRANCISCO—The Federal Rubber Co., Cudahy, Wis., will soon award the contract for the construction of a 5-story factory for the manufacture of tires, etc. Estimated cost, $150,000. G. B. Allen, archt. and engr.

Connecticut

NAUGATUCK—The Rubber Regenerating Co., Elm St., has awarded the contract for the construction of a 1-story addition to machine shop and alterations to other buildings at plant to the F. T. Ley Co., Inc., 499 Main St., Springfield, Mass. Estimated cost, $50,000.

NEW HAVEN — The Nustone Products Corp., Waterfront St., will build a 1-story, 95x100-ft. stone products factory. Estimated cost, $12,000. Work will be done by day labor.

UNION CITY (Naugatuck P. O.)—The Eastern Malleable Iron Co. has awarded the contract for altering and building additions to the present plant to the Fred T. Ley Co., Inc., 499 Main St., Springfield, Mass. Estimated cost, $50,000.

VERSAILLES—The Versailles Sanitary Fibre Mills has awarded the contract for the construction of a paper factory to the H. Wales Lines Co., 134 State St., Meriden. Estimated cost, $100,000.

Delaware

WILMINGTON—The Wilmington Sugar Refining Co. plans to build a sugar refinery. Estimated cost, $2,000,000. W. Higginson, 18 East 41st St., New York City, archt. and engr.

Illinois

CHICAGO—The Coca-Cola Co. plans to build a plant on Crawford and Karlov Aves. Estimated cost, $750,000.

CHICAGO — The Sherwin-Williams Co., 116th St. and Stephenson Ave., is building a white lead manufacturing plant and is in the market for equipment for the manufacture of litharge and red lead.

Kansas

CHANUTE—The Mutual Oil Co., Mutual Bldg., Kansas City, Mo., will build a 3-story, 35x90-ft. wax plant for the manufacture of lubricating oil. Estimated cost, $100,000. Work will be done by day labor.

TOPEKA—The Topeka Fdry. & Iron Co., 318-322 Jackson Ave., plans to construct 3 buildings, including a foundry and machine shop. Estimated cost, $100,000.

Maine

WATERVILLE — The Keyes Fibre Co. has awarded the contract for the construction of a paper factory to the Aberthaw Constr. Co., 27 School St., Boston. Estimated cost, $100,000. Webster & Leroy, 534 Congress St., Portland, engrs.

Maryland

BALTIMORE—The Bd. of Awards has awarded the contract for the construction of a hydrolytic tank, sludge digestion tank, etc., at the sewage disposal works, west shore Back River, to the Robertson Bros., 106 Hopkins Pl.

BALTIMORE—The Interocean Oil Co., East Lexington St., plans to build a 1-story, 80x38-ft. chemical laboratory. Estimated cost, $7,788. O. F. Adams, archt.

BALTIMORE—The Whitaker Paper Co., 415 Guilford Ave., has awarded the contract for the construction of an 8-story, 100x186-ft. warehouse on Guilford Ave., Saratoga and Davis Sts. to the Turner Constr. Co., 244 Madison Ave., New York City. Estimated cost, $600,000.

Massachusetts

EAST PEPPERELL—The Nashua River Paper Co. plans to build a paper factory addition. Estimated cost, $100,000.

HOLYOKE — The Perfect Safety Paper Co., Winter St., plans to build a 60x100-ft. paper factory addition on Appleton and Winter Sts. Estimated cost, from $75,000 to $100,000. Howes & Howes, 243 High Sts., archts.

Michigan

MARYSVILLE—The Aluminum Castings Co., c/o E. E. Allyne, 2800 Harward Ave., Cleveland, O., plans to build a 2-story factory. Estimated cost, $75,000.

ONTONAGON—The Northern Fibre Co. has awarded the contract for the construction of a 2-story pulp mill to W. E. Ule, Stevens Point, Wis. Estimated cost, $350,000.

OWOSSO—The city has awarded the contract for furnishing labor and material for the construction of a water filtration plant with 1,000,000 gal. capacity to the Ann Arbor Asphalt Constr. Co., Ann Arbor. Estimated cost, $75,000.

Minnesota

WABASSO—The city rejected all bids for the construction of a sewage treatment plant and general sewer. Estimated cost, $45,000. J. F. Druar, 512 Globe Bldg., St. Paul, engr. Noted Sept. 1.

Missouri

EXCELSIOR SPRINGS—The city plans an election Oct. 4 to vote on $25,000 bonds to construct a disposal plant, etc. Shockley Eng. Co., Kansas City, engr.

MOBERLY — The city is having plans prepared for the construction of an impounding dam, filter plant, etc. Estimated cost, $350,000. Fuller & Beard, Chemical Bldg., St. Louis, engrs. Noted July 14.

SPRINGFIELD — The Wood Everett Stove Co. plans to build a 2-story foundry. Estimated cost, $100,000.

WEBB CITY—The Rock Paint & Cloth Co. is having plans prepared for the construction of a 2-story, 61x150-ft. paint factory. Estimated cost, $150,000. Bucy Miller Eng. Co., Joplin, engrs.

Nebraska

CHAPPELL—The city plans to build a sewage disposal plant and sewer system. Sewage treatment and Imhoff tank and sand filters will be installed in same. Estimated cost, $90,000. Hensingson Eng. Co., 12th and Harney Sts., Omaha, engrs.

North Dakota

HURDSFIELD—The Bd. Educ. will soon award the contract for the construction of a 2-story, 68x89-ft. grade and high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. R. H. Corson, clk. W. D. Gillespie, Fargo, archt.

Ohio

AKRON—The Miller Rubber Co., South High St., will build a 3-story, 60x210-ft. factory. Estimated cost, $100,000. Work will be done by day labor.

CLEVELAND—The Bd. Educ. will receive bids until October 1 for the construction of a 1-story sewage treatment and water pumping plant. Estimated cost, $50,000. C. W. Bates, Natl. Bank Bldg., Wheeling, W. Va., archt.

CLEVELAND—The Peerless Motor Car Co., East 93rd St. and Quincy Ave., rejected bids for the construction of a 1-story, 60x100-ft. japanning building. Estimated cost, $100,000. Carter, Richards, Griffith Co., Illuminating Bldg., archts. and engrs.

COLUMBUS—The city will receive bids until Oct. 4 for the construction of additions and repairs to the sewage disposal plant on Dawson Ave. P. N. Roderick, village clk.

Oklahoma

DOUGHERTY—The Continental Asphalt & Refining Co., Oklahoma City, will build a refinery here. Estimated cost, $1,000,000. Work will be done by day labor.

OKLAHOMA CITY—The city will soon receive bids for the construction of a sewage disposal plant. Estimated cost, $1,000,000. Pierce, Greeley & Hansen, 39 West Adams St., Chicago, Ill., engrs. Noted July 14.

SPIRO—The city plans an election Nov. 4 to vote on $50,000 bonds to construct a sewage disposal plant, etc.

Pennsylvania

PHILADELPHIA—E. Hubschman, Orianna and Willow Sts., has awarded the contract for the construction of a 1-story, 60x90-ft. leather factory addition, to Mongahan & Losse, 3016 Chestnut St.

PHILADELPHIA—McIlvain Bros., 15th and Hamilton Sts., will soon award the contract for altering their drug factory. Ballinger & Perrot, 329 South Broad St., archts.

Rhode Island

PROVIDENCE—Brown University, Prospect St., will soon award the contract for the construction of a 3-story, 50x200-ft. laboratory. Estimated cost, $250,000. Day & Klauder, 925 Chestnut St., Philadelphia, Pa., archts. and engrs. Noted Aug. 25.

Texas

WICHITA FALLS — The State Bd. of Control, Austin, will receive bids until Oct. 4 for the construction of a sewage disposal plant, etc., at the Northwest Texas Insane Asylum, here. C. H. Page & Bros., Austin Natl. Bank Bldg., Austin, archts.

Wisconsin

BELGIUM—The city had plans prepared for the installation of septic tank, etc. Estimated cost, $25,000. J. Donohue, 8th St., Sheboygan, engr.

HARTFORD—The city is having plans prepared for the installation of sewage disposal tanks, etc. Estimated cost, $25,000. C. Leins, West Bend, engr.

MILWAUKEE—The Natl. Brake & Electric Co., Belleview Pl., has awarded the contract for the construction of a 1-story, 164x180-ft. foundry addition to Paul Riesen's Sons, 1000 Humboldt Ave. Estimated cost, $250,000. Noted April 21.

OSHKOSH — The Mercy Hospital, 185 Hazel St., is having plans prepared for the construction of a 4-story hospital addition and nurses' home on Hazel St. Chemical laboratories will be installed in same. Estimated cost, $600,000. E. Brielmoier & Sons, University Bldg., Milwaukee, archts and engrs.

SHEBOYGAN — The Columbia Rubber Mills, 176 16th St., Milwaukee, has awarded the contract for the construction of a 2-story, 100x170-ft. factory to Herman Loesing, 914 Superior St. Estimated cost, $60,000. Noted Aug. 11.

SHEBOYGAN—The Tomah Rubber Co., 176 16th St., Milwaukee, has awarded the contract for the construction of a 2-story, 70x100-ft. rubber factory on Lymans Ave. to H. Loesing, 914 Superior St. Estimated cost, from $50,000 to $60,000. Noted Aug. 4.

Ontario

LONDON—The Daughters of the Empire has awarded the contract for the construction of a 3-story, 100x280-ft. children's hosptial on Ottawa Ave., to John Putherbough, 272 Regent St. Special laboratory equipment will be installed in same. Estimated cost, $250,000.

OTTAWA—The Ottawa Paint Works, 687 Wellington St., has awarded the contract for altering paint factory on Wellington St. to A. Christie & Son, Kensington Apts., Elgin St. Estimated cost, $50,000.

SANDWICH EAST—The city plans an election to vote on $200,000 bonds to construct intercepting sewers, sewage disposal plant, etc. Morris Knowles, Ltd., Heintzman Bldg., Windsor, engr.

Toledo

TOLEDO—The Maumee Tire & Rubber Co., 705 Madison Ave., is having plans prepared for the construction of a 3-story, 100x300-ft. rubber tire factory on Lackey Rd. Estimated cost, $300,000. G. G. Morrison, pres. Osborn Eng. Co., 2848 Prospect Ave., archt. and engr.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN ENGINEERING COUNCIL of the Federated American Engineering Societies will hold a meeting Nov. 18 and 19, 1920, in Washington, D. C. Headquarters will be at the New Willard Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its 1920 convention and exhibit at Columbus, Ohio, the week of Oct. 4.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building, from Dec. 7 to 10 inclusive.

CANADIAN INSTITUTE OF MINING AND METALLURGY will hold its second annual Western meeting in Winnipeg, Man., on Oct. 25, 26 and 27. Headquarters will be at the Hotel Fort Garry.

ELECTRIC FURNACE ASSOCIATION will hold a meeting Oct. 6, at Columbus, Ohio, the subject of which will be "Refractories."

ENGINEERING COUNCIL will hold its next meeting in Chicago, Thursday, Oct. 21.

INSTITUTE OF METALS DIVISION OF THE A. I. M. E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

NATIONAL ASSOCIATION OF PURCHASING AGENTS will hold its annual convention at the Congress Hotel, Chicago, Ill., Oct. 11, 12 and 13.

THE RUBBER SECTION of the National Safety Council will consider safety problems of especial interest to the rubber industry at a section conference to be held Sept. 29 to Oct. 1, in connection with the national session of the Council to be held in Chicago.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12.

Industrial Notes

W. S. ROCKWELL Co., New York, calls attention to Bull. 217, dated June, 1920, on "Automatic and Semi-Automatic Furnaces for the Continuous Heat-Treatment of Metals." This bulletin is a review of methods and equipment that the company has developed in recent years and which have shown their value in practice.

WELLER MFG. Co., Chicago, Ill., is issuing a four-page folder on coal handling equipment which helps solve the labor problem.

EUGENE WUERZ, Brooklyn, N. Y., designer and builder for the enamel, glass, iron and steel industries of patent recuperator system furnaces, has issued a booklet giving illustrations and descriptions of different furnaces, together with illustrations of actual installations.

ROSS-TACONY CRUCIBLE Co., Philadelphia, Pa., has issued an illustrated booklet on its crucibles, phosphorizers, retorts, stirrers, skimmers, etc., special crucibles, stoppers, nozzles and sleeves.

WESTON DODSON & Co., INC., announces the appointment, as export sales manager, of F. R. Wadleigh, formerly consulting and export engineer, vice J. H. Davison, resigned, and of J. W. Sands as assistant export sales manager.

W. M. HUMPHREY has purchased the plant of the Gas Oil Chemical Co. of Hammond, Ind., and will enter immediately into the manufacture of dye intermediates, including paratoluidine, orthotoluidine and paranitrotoluol.

THE KEWAUNEE MFG. Co., Kewaunee, Wis., has elected C. G. Campbell a member of the board of directors and has appointed him general manager.

THE POWERS REGULATING Co. has recently moved into a large modern fire-proof factory building having floor space of about 40,000 sq.ft. The company has grown to this size from the small beginnings in 1890 when W. P. Powers turned out the first house regulators in a small room 12 x 16 ft. Recently the older employees of the company, including one who has been with the organization from the beginning, presented W. P. Powers, their president, with a silver cup in token of their affection and esteem.

THE SIMONDS MFG. Co. has just completed an addition 40 x 50 to its research laboratory connected with its steel mills at Lockport, N. Y. Additional equipment consisting of a 300 to 500 lb. capacity special type electric melting furnace, several electric heating furnaces and other tools and equipment have been installed, with a view of greatly extending facilities for carrying on development and research work. New formulas and methods for making special steels will be worked out at the enlarged laboratory under the direction of an expert metallurgical staff.

THE WESTINGHOUSE ELECTRIC & MFG. Co.'s war memorial scholarship committee has announced as the winners of the four scholarships for the coming year, 1920-21, Alva C. Corrao, small motor drafting department; Henry Gardiner Symonds, son of N. G. Symonds, manager industrial sales division, Chicago office; J. Dale Seabert, transformer engineering department, and Herbert R. Hillman, son of William A. Hillman, who has been a machinist in the works of the R. D. Nuttall Co. for twenty-seven years. These memorial scholarships were established in 1919 as a means for perpetuating the memory of those employees of the Westinghouse company and its subsidiary companies who took part in the great war. Each scholarship carries with it the annual payment of $500 for a period not to exceed four years. The payment is to be applied towards an engineering education in any technical school or college selected by the successful candidate. Scholarships are granted for one year only, and approved by the scholarship committee, but are continued for the full course provided the scholar maintains the academic and other standards required by the institution. The awarding of the scholarships is based upon the personal character of the applicants and grades in examinations.

ABBOT A. HANKS, who has long conducted an assay office and chemical laboratory at 630 Sacramento St., San Francisco, and testing laboratories in separate quarters, has recently moved into a new and larger building at 624 Sacramento St. The new building will house the entire laboratory equipment and contains a sampling room, an assay room, a chemical laboratory with dark room, a testing laboratory and a library. The more commodious quarters permit of the efficient arrangement of equipment and allow space for additional apparatus. The testing laboratory is thoroughly equipped to handle materials of construction and commerce. There is a growing demand for this class of work both in volume and variety due to the increase in foreign trade through the port of San Francisco as well as because of the evident need of inspection of incoming and outgoing shipments. The testing laboratory has an experienced personnel and is in position to perform efficient service.

CHARLES WHITING BAKER, for many years editor-in-chief of *Engineering News* and since 1917 consulting editor of *Engineering News-Record*, announces his resignation and the establishment, under his direction, of the Engineering Business Exchange, with offices at 30 Church St., New York City, an agency to bring together those desiring to sell any sound engineering or technical business—manufacturing, constructing, selling or professional—and those seeking opportunities to purchase.

THE AJAX ELECTROTHERMIC CORP., Trenton, N. J., announces that Dr. E. F. Northrup has recently been elected vice-president of the company and is now engaged in perfecting the brass-melting furnace of the Ajax-Northrup type. Dr. Northrup has resigned his professorship at Princeton University in order to devote his entire time to the business of the company.

Manufacturers' Catalogs

THE PENNSYLVANIA FORGE Co., Bridesburg, Philadelphia, Pa., has issued a 32-page booklet on Forges and Pressed Steel Die Blocks Made from Acid O.H. Steel. This booklet is known as Cat. No. 3.

THE MONARCH MFG. WORKS, INC., Philadelphia, Pa., has issued a 4-page folder, Cat. 6, Section C, on improved chemical sprays, which gives descriptive matter and illustrations.

THE WARREN CHEMICAL DIVISION of The Barrett Co., New York, calls attention to a small booklet on Alkali and Acid-Proof Anchor Rock Asphalt Floors.

THE MINE & SMELTER SUPPLY Co., New York City, has just received from the press Bull. No. 63, on Massco Furnaces for melting, hardening, tempering, annealing, forging, assay work, ore roasting, etc., using oil, gas or gasoline fuel. This attractive 48-page booklet gives illustrations and descriptive matter of the following furnaces: crucible tilting; potless tilting; small stationary gas; gasoline melting; muffle; rod heating; pack hardening; billet forge; annealing; oil forge; die hardening; reverberatory and mechanical roasting, together with burners, accessories and motor blowers.

MOJONNIER BROS. Co., engineer, Chicago, has just issued a new 160-page catalog on Scientific Dairy Apparatus and Supplies, wherein is shown a comprehensive line of the company's own apparatus, also a very complete line of laboratory accessories for the chemical and bacteriological control of milk and milk products. The second section of the catalog is devoted to vacuum pans, sterilizers, pumps and a complete line of heavy machinery used in condensed and evaporated milk plants.

LEEDS & NORTHRUP Co., Philadelphia, Pa., has issued Cat. No. 75, entitled "Electrometric Methods and Apparatus for Determining Hydrogen Ion Concentrations." This booklet contains the following: General Considerations, The Working Formulas, Electrometric Methods Applicable to Hydrogen Ion Measurements, Methods Employing Potentiometer Principle, Practical Considerations in Applying Working Formulas, Applications of the Gas Chain to Titration Analysis, Industrial Applications of Gas Chain Methods, Bibliography and Price List.

THE YARNALL-WARING Co., Philadelphia, Pa., is distributing Bull. No. 410, descriptive of the Yarway seatless and double tightening blow-off valves, both separately and in combination. The Yarway double tightening valve is a new development, having been designed primarily to use in conjunction with the seatless valves in certain states where boiler laws require use of either two valves or a blow-off valve and a cock on each individual blow-off line. This conforms with the A.S.M.E. boiler code. A copy will be sent upon request.

THE OXWELD ACETYLENE Co., Chicago, Ill., has its new "Eveready" catalog ready for the public. The catalog is issued in sections, each devoted to a particular phase of "Eveready" equipment—welding and cutting blowpipes, regulators, accessories, etc. The "Eveready" line was formerly manufactured under the name of "Prest-O-Lite" apparatus by the Prest-O-Lite Co., and was extensively used in the metal trades. The Oxweld company took over the production and sales under the present name— Eveready—early in 1920, incorporating certain improvements in design lately developed in oxy-acetylene engineering. For the benefit of users of Eveready welding and cutting apparatus who desire special information on any particular phase of the industry, a series of small printed pamphlets containing matter excerpted from the Eveready instruction book and catalog. Among the subjects ready for distribution are: Directions for Operating Lead Burning Equipment, 12 pages; Directions for Operating Welding Equipment, 12 pages; Directions for Operating Cutting Equipment, 8 pages. Each pamphlet contains a detailed list of parts comprising the equipment treated. Copies are mailed free on request.

THE LOOMIS-MANNING FILTER DISTRIBUTING Co., Philadelphia, Pa., calls attention to a new catalog on its filters, which insure clean, safe, freshly-filtered water for all uses.